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2.0 PROJECT DESCRIPTION AND ENGINEERING

This chapter describes the Project, which consists of construction and operation of a state-of-the-art 600 MW combined-cycle electric power generating plant and ancillary facilities. The Project will be located on a portion of an approximately 148-acre parcel (the Site) in the northeast corner of the City of Avenal, Kings County, California (Figures 2.0-1 and 2.0-2). The Applicant for this Application for Certification (AFC) is Duke Energy Avenal, LLC (Duke Avenal).(1) Duke Avenal proposes to construct and operate the Project on a schedule to provide power to the California grid system, with commercial operation beginning in 2004, contingent upon successful and timely permitting and continued support for the Project. Construction and operation of the Project will make a substantial contribution toward supporting California's energy infrastructure with minimal environmental effects. Duke Avenal's basic Project objectives are to:

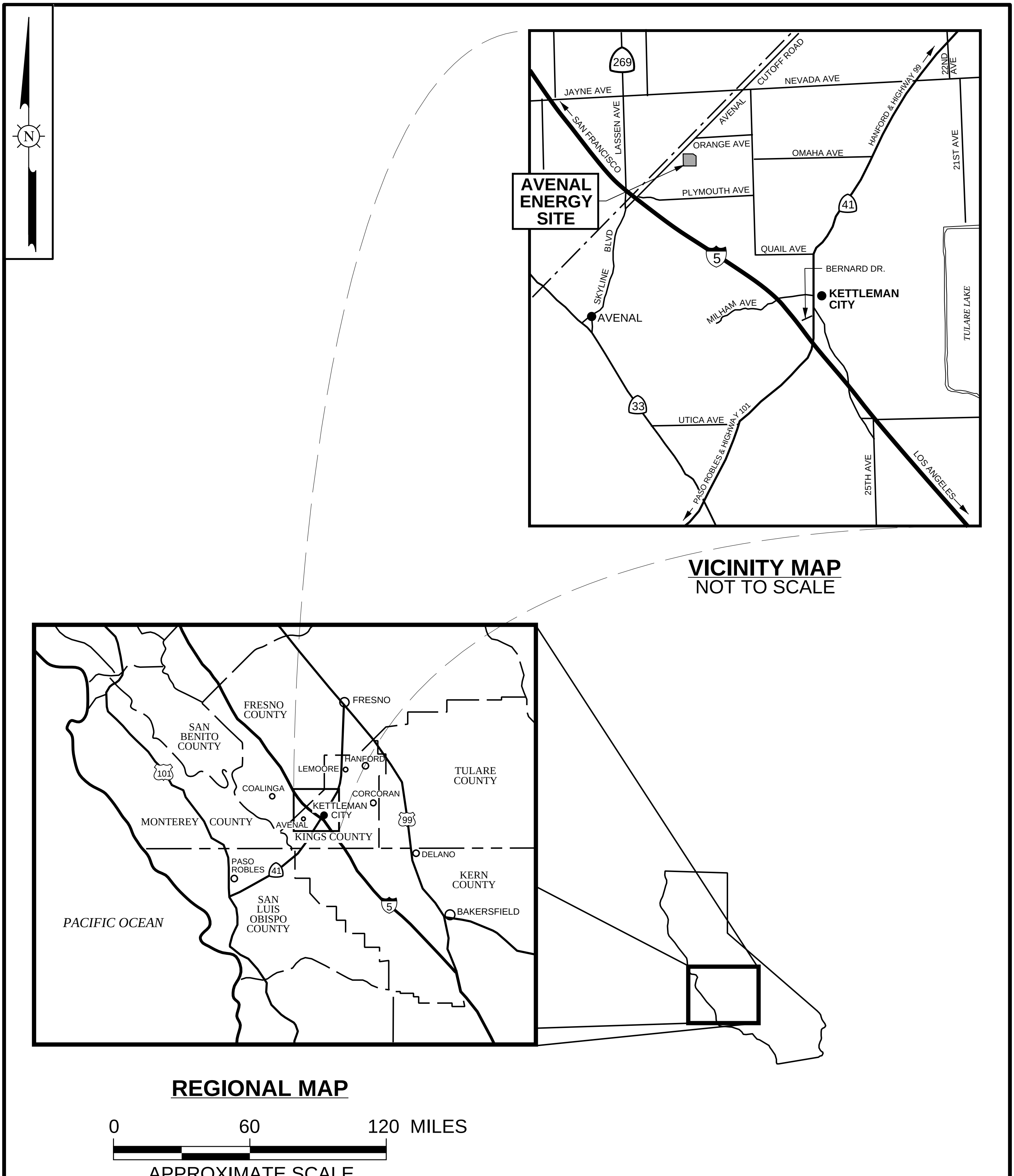
- Provide environmentally sound, efficient and reliable power generation for California's restructured energy market.
- Use a location that has existing nearby infrastructure (i.e., existing transmission lines, water supply and gas supply) with available capacity and supply to support the Project.
- Develop a site consistent with community planning and existing zoning, at a location that is supported by the local community.
- Minimize impacts to environmental resources.

The Project is described in detail in the following sections:

- Section 2.1 provides an introduction to general Project and Site background information, including the Project location and general description.
- Section 2.2 provides an overview of benefits the Project will provide to California businesses, residents and government.
- Section 2.3 provides details of the generation facility description, engineering design, construction and operation.
- Section 2.4 provides details of the transmission line description, engineering design and operation.

(1) Duke Energy Avenal, LLC, a Delaware Limited Liability Company, is referred to throughout this document as "Duke Avenal."

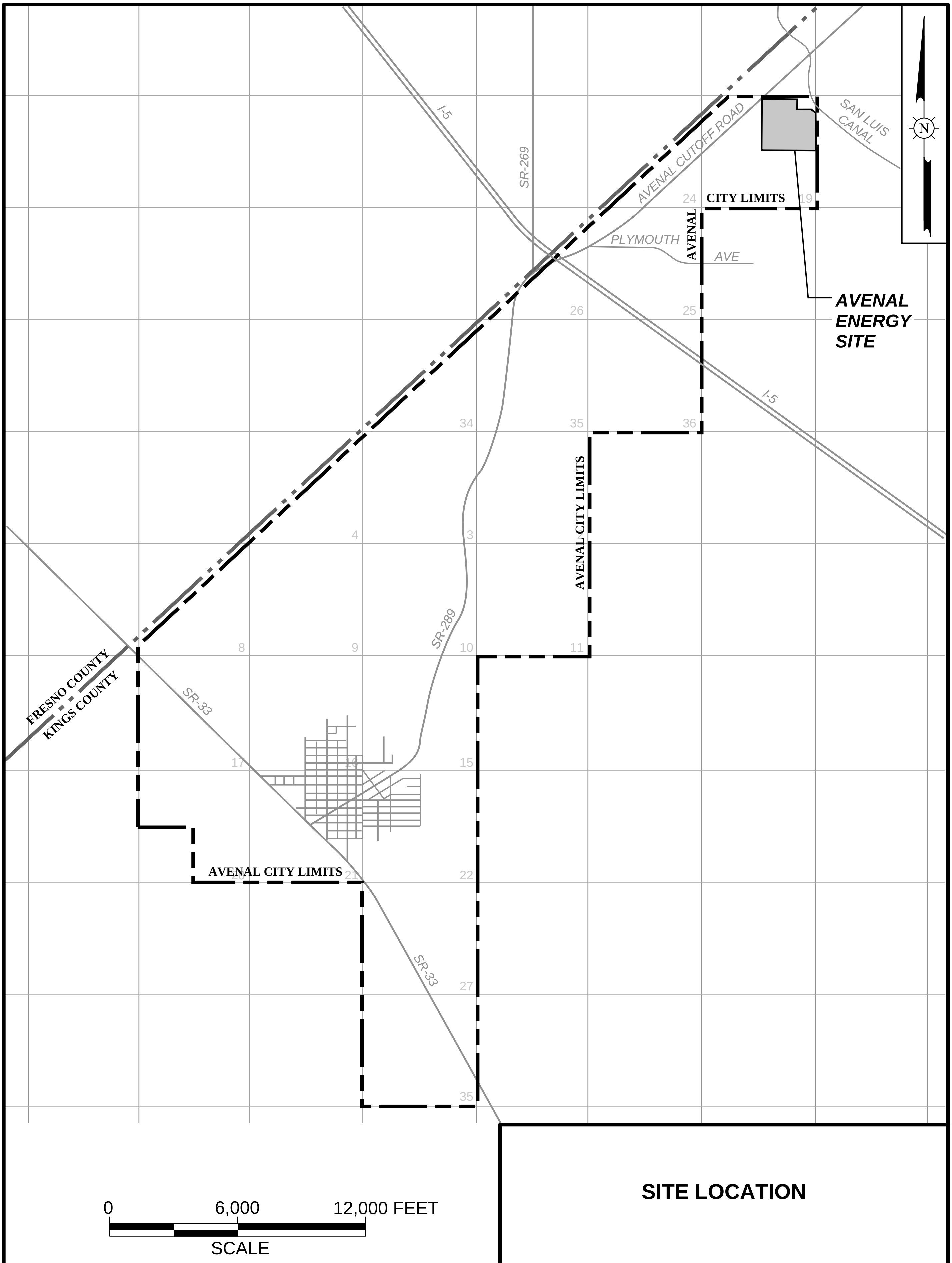
00-311AFC-21 REV 08/20/01



REGIONAL LOCATION MAP

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	FIGURE 2.0-1



REFERENCE: CITY OF AVENAL GENERAL PLAN, EXHIBIT 2.

SITE LOCATION

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY | FIGURE 2.0-2

00-311AFC-72 REV.09/13/01

- Section 2.5 provides a summary of laws, ordinances, regulations and standards (LORS) applicable to Project design and engineering, and references the sections in this chapter that discuss how compliance with those LORS will be achieved.

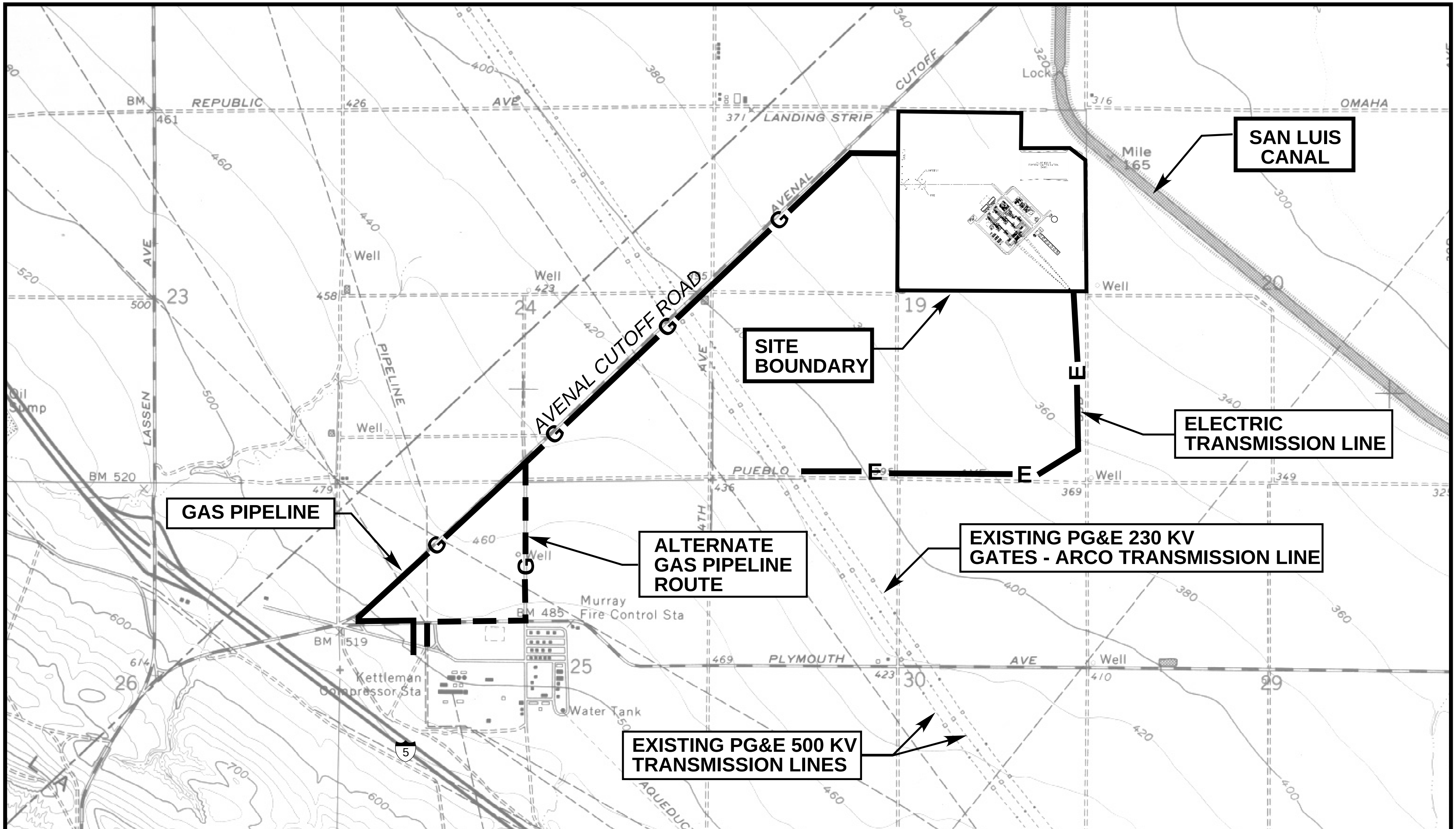
2.1 INTRODUCTION

2.1.1 GENERAL

The Project will produce a nominal electrical power output of 600 MW for delivery to the California grid system, using clean-burning natural gas. The Project has been located and designed to minimize environmental impacts. The Project Site is zoned industrial and is located close to existing gas, water and electrical transmission infrastructure facilities, so only short linear facility tie-ins are required. Natural gas for the Project will be provided via an underground pipeline interconnection to an existing PG&E gas line at the Kettleman compressor station, located approximately 7,000 feet southwest of the Site (Figure 2.1-1). The Project will deliver electric power to the PG&E transmission grid through a new, onsite 230-kV switchyard by constructing approximately 7,000 feet of new, double circuit 230-kV line to loop the existing PG&E Gates-ARCO 230-kV line into the Site. A dependable water supply will be provided by the KCWA through an exchange of its local water supply with KCWA's State Water Project entitlement and other water. The water will be delivered via the San Luis Canal (California Aqueduct). A backup water supply will be available from nearby agricultural wells and conservation measures will assure no net increase in groundwater pumping. The Project will include a ZLDF that will purify and recycle process blowdown, minimizing water consumption and eliminating process wastewater discharge.

2.1.2 PROJECT LOCATION

The Site is located in an agricultural region along the western edge of the San Joaquin Valley, approximately 2 miles east of Interstate 5, about 200 miles south of San Francisco and 200 miles north of Los Angeles. Access to the Site is via Avenal Cutoff Road. The Site is separated from the residential and commercial districts of the City of Avenal by a distance of about 6 miles and the intervening topography of the Kettleman Hills (Figure 2.1-2). The City of Avenal has zoned the area for development of an industrial park, in part due to its proximity to Interstate 5 and to the natural gas supply at the PG&E Kettleman compressor station. The closest population center is the residential district of Avenal, located approximately 6 miles to the southwest.



REFERENCE:
U.S.G.S 7.5 MINUTE TOPOGRAPHIC SERIES MAP OF LA CIMA, CALIFORNIA, DATED 1978.

0 2,000 4,000 FEET
SCALE

NATURAL GAS AND ELECTRICAL INTERCONNECTION ROUTES

DUKE ENERGY AVENAL LLC

AVENAL ENERGY **FIGURE 2.1-1**

The City of Huron is located approximately 8 miles to the north, and the City of Coalinga is located approximately 16 miles to the west.

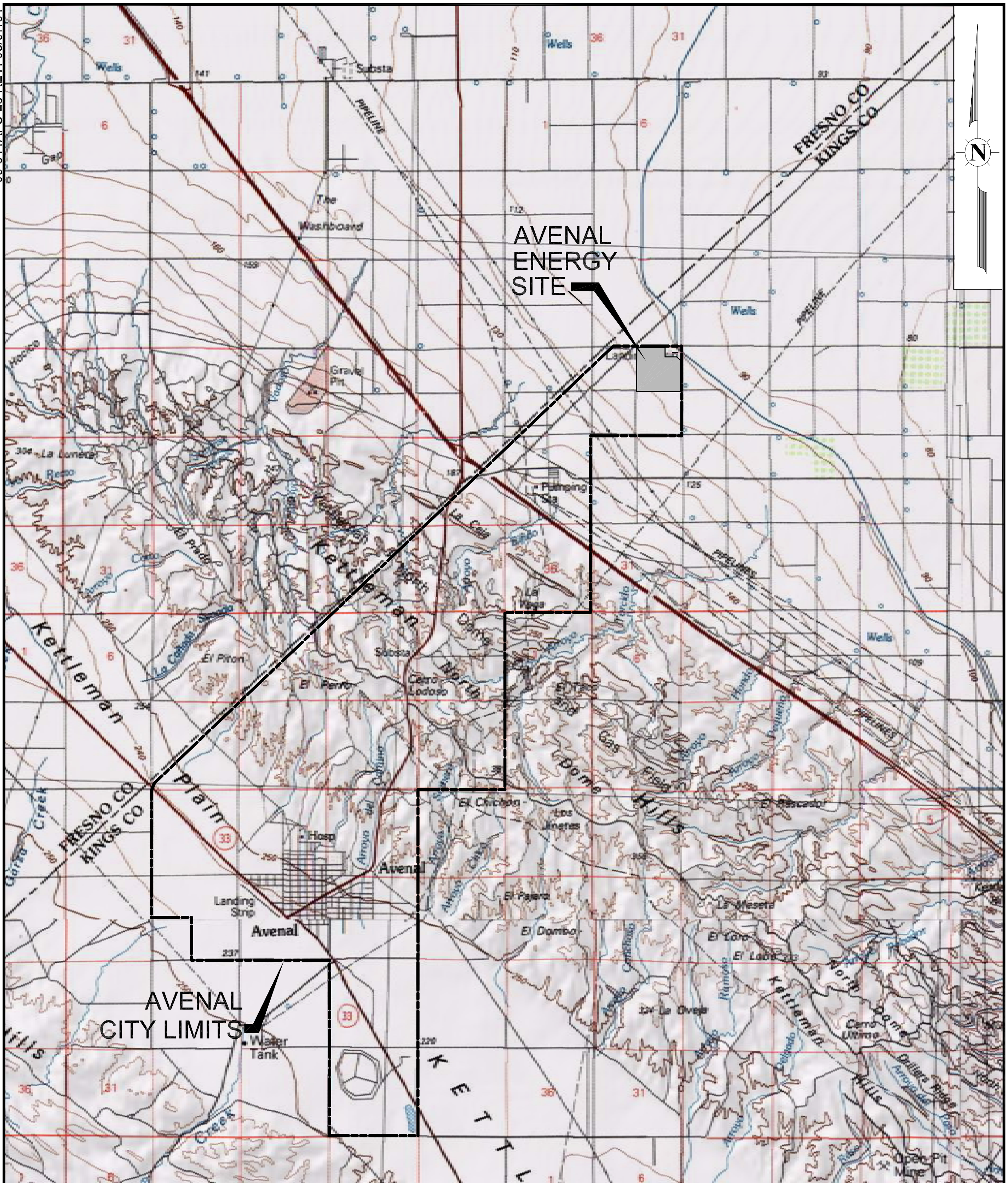
The Site constitutes the majority of the northeast quarter of Section 19, Township 21 South, Range 18 East, Mt. Diablo Base and Meridian (Figure 2.1-3A). Duke Avenal has secured the Site, which is located on a portion of the Kings County Assessor's Parcel No. (APN) 36-170-032. The Site is surrounded by open farmland except for a City of Avenal water treatment facility where water is diverted through a turnout on the San Luis Canal and treated for potable use. A pipeline conveys the potable water over the Kettleman Hills to the commercial and residential area of the City of Avenal and to Avenal State Prison.

The Site together with all related facilities and land ownership/easements related to the Project are shown in Figure 2.1-3B. The land comprising the Site will be owned by Duke Avenal. The natural gas pipeline from the Site to its connection with a PG&E pipeline at the Kettleman compressor station will pass across farmland via easements granted by the owners of the land, and in Avenal Cutoff Road. The electric transmission line will cross farmland to its connection with an existing PG&E transmission line pursuant to an easement granted by the owner of the farmland. Water lines from the Site to the wells also use easements from the same farmer.

2.1.3 SITE DESCRIPTION

The Site and Project linear facilities are located entirely in areas that have been extensively disturbed by agriculture and infrastructure development and, consequently, no natural habitat will be impacted. The Site is characterized by relatively featureless terrain that slopes gently from the Kettleman Hills to the northeast and ranges in elevation from approximately 360 feet to approximately 320 feet above sea level. The marine sedimentary rocks that comprise the Kettleman Hills occur at depth below the Site and are overlain by a thick sequence of alluvial deposits derived from erosion of the Kettleman Hills and coast ranges to the west. The climate is dry; with an average rainfall is between 6 and 7 inches per year. There are no natural perennial surface waters in the immediate vicinity of the Site. The prevailing wind direction is northwest, with a mean wind speed of 6 miles per hour. Temperature ranges from the high 30s into the low 100s. The Site plan is shown in Figure 2.1-4. An aerial photograph is provided in Figure 2.1-5. Photographs of the Site area are also included in Section 6.13 - Visual Resource Analysis.

00-311AFC-23 REV. 08/07/01



REFERENCE: Printed from TOPO!
© 2000, National Geographic Holdings
(WWW.TOPO.COM)

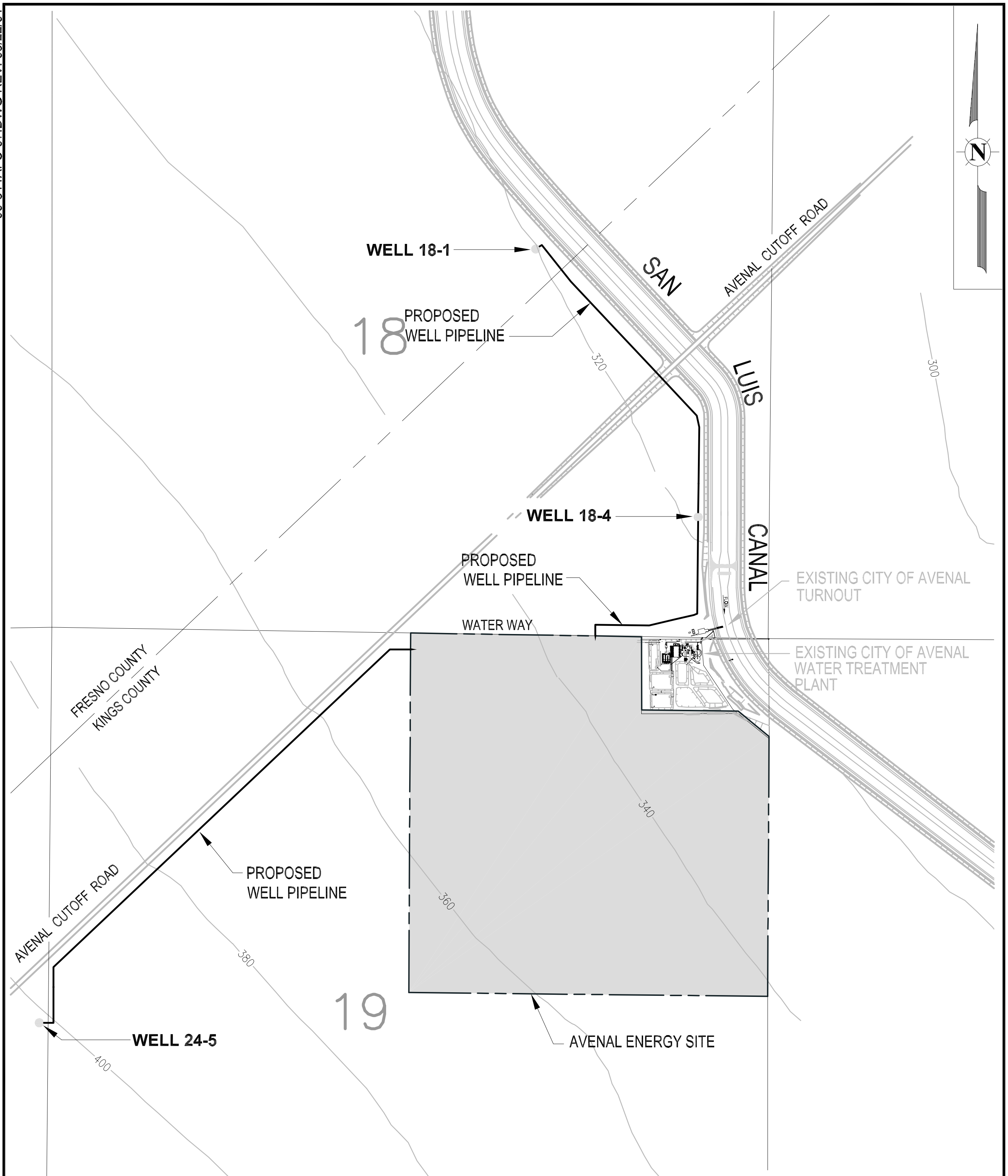
0 8,000 16,000 FEET
SCALE

LOCAL TOPOGRAPHY

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY | **FIGURE 2.1-2**

00-311AFC-07.DWG REV. 09/22/01



REFERENCE: SUMMERS ENGINEERING, INC.,
LOCATION MAP, WATER SUPPLY AND
TREATMENT FACILITIES WITH OPTION B,
PRELIMINARY, MARCH 7, 2001.

0 1,000 2,000 FEET

SCALE

SITE PARCEL MAP

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY

FIGURE 2.1-3A

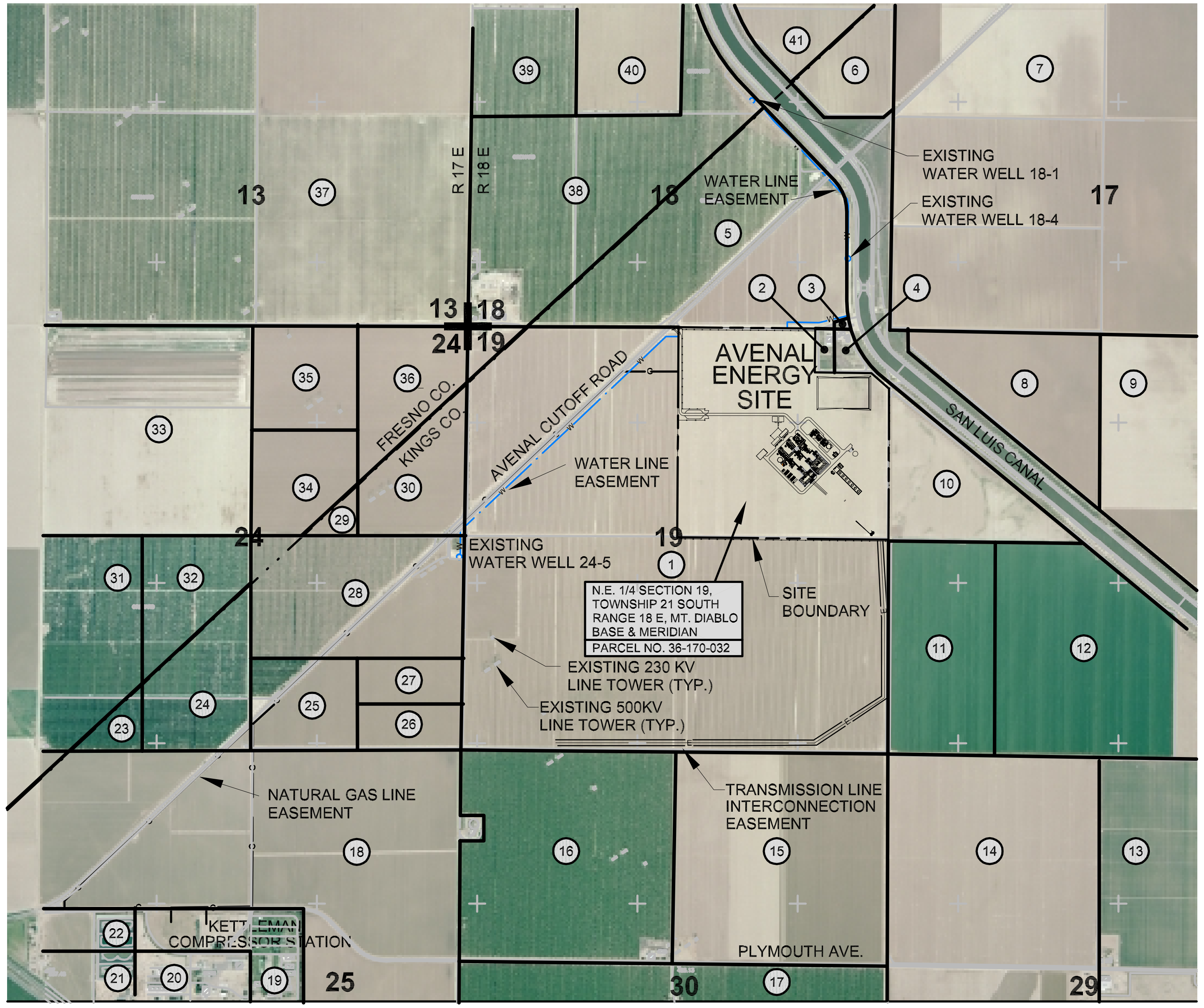
2.2 OVERVIEW OF PROJECT BENEFITS

The Project represents a "win-win" situation that will provide long-term benefits to both the City of Avenal and Kings County, and support to California's energy infrastructure needs. Recognizing the benefits of the Project, officials from the City of Avenal have been working with Duke Avenal for more than a year developing plans for the Project. The Project proposal is a result of the City's effort and continuing support by Kings County for this infrastructure improvement. Key benefits of the Project include:

- The site does not contain environmental resources that could be impacted by the introduction of a power plant.
- Increased electrical power to the grid, capable of supporting about 450,000 homes or small businesses.
- Reduced cost of electricity to California consumers due to increased generating efficiency and environmentally superior technology compared to older technology generating units currently operating in California.
- Expanded revenue base for local governments, including property and sales taxes, franchise fees and indirect income.
- Construction jobs with focus on local hiring and permanent work force of management and skilled technical positions.
- Diversification of the existing agricultural based economy for the City of Avenal and Kings County.

2.2.1 BACKGROUND

The City's lands east of Interstate 5 and south of Avenal Cutoff Road are zoned industrial. The area is zoned industrial in part due to the available natural gas supply at the PG&E Kettleman compressor station and proximity to Interstate 5 (City of Avenal General Plan, 1992).



0 2,000 4,000 FEET
SCALE

LEGEND:

ASSESSORS PARCEL BOUNDARY
(15) PARCEL NUMBER
13 SECTION NUMBER
SITE PROPERTY LINE
PROPOSED GAS PIPELINE ROUTE
ALTERNATE GAS PIPELINE ROUTE
PROPOSED TRANSMISSION LINE ROUTE
PROPOSED WATER LINE ROUTE
EXISTING WATER WELL LOCATION

KEY:	ASSESSOR'S PARCEL NO.:
1	036-170-032
2	036-170-031
3	036-170-020
4	036-170-018
5	036-170-027
6	036-170-030
7	036-170-002
8	036-170-012
9	036-170-014
10	036-170-013
11	036-170-026
12	036-170-025
13	036-170-055
14	036-180-054
15	036-180-044
16	036-180-043
17	036-180-042
18	038-010-043
19	038-010-038
20	038-010-039
21	038-010-037
22	038-010-042
23	038-380-008
24	038-380-005
25	038-380-006
26	038-031-001
	038-031-002
	038-031-003
	038-031-004
	038-031-012
	038-031-013
	038-031-015
	038-031-019
	038-031-020
	038-032-001
	038-032-004
	038-032-005
	038-032-007
	038-032-008
	038-032-009
26	038-033-003

KEY:	ASSESSOR'S PARCEL NO.:
27	038-021-001
	038-021-002
	038-021-003
	038-021-005
	038-021-007
	038-021-008
	038-021-009
	038-021-010
	038-021-012
	038-021-016
	038-021-018
	038-021-022
	038-021-023
	038-021-024
	038-021-025
	038-022-001
	038-022-002
	038-022-003
27	038-023-003
28	038-380-004
29	038-380-007
30	038-380-002
31	085-090-079
32	085-090-083
33	085-090-007
34	085-090-078
35	085-090-057
36	085-090-077
37	078-090-063
38	078-090-026
39	078-090-002
40	078-090-022
41	078-090-018

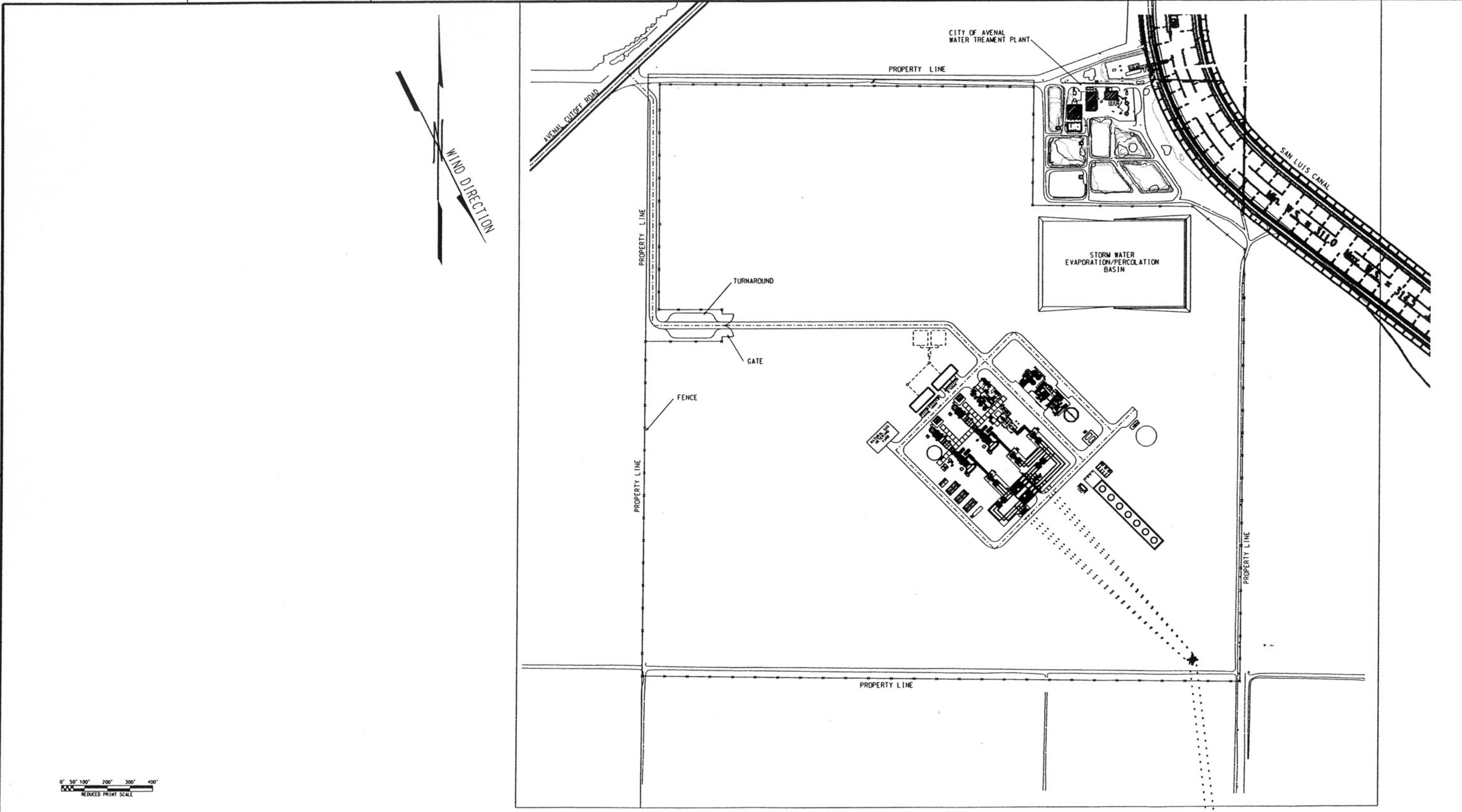
NOTE: APPENDIX 1.0-1 PROVIDES A LIST OF CURRENT TAX ASSESSOR'S PARCEL NUMBERS AND OWNER'S NAMES AND ADDRESSES FOR PARCELS WITHIN 500 FEET OF PROPOSED LINEAR FACILITIES AND WITHIN 1,000 FEET OF THE SITE.

PROJECT FACILITIES AND LAND OWNERSHIP / EASEMENTS

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY

FIGURE 2.1-3B



REV.	DATE	REVISION DESCRIPTION	DRWN / CHK.	LAYO / SYS	CSA / ELEC	ENGM / PROJ	DWG.NO.	REFERENCE DRAWINGS
G	08-23-01	UPDATED PER LATEST DESI TRANSMISSION LINE	BC					
B	06-19-01	REVISED & ROTATED WATER DETENTION POND. REVISED ACCESS ROAD. ADDED GATE & FENCE	BC					
C	06-22-01	ISSUED FOR AIR MODELING	BC					
D	07-08-01	RELOCATED CHILLERS 30' N-W TO LEAVE ROOM FOR SWITCHYARD	BC					
E	07-26-01	REVISED WATER TANK & FIREWATER PUMPS	TO					
F	07-26-01	RELOCATED FIREWATER PUMP HOUSE AND RAW WATER/FIREWATER STORAGE TANKS	BN					

RESERVED FOR PROFESSIONAL ENGINEER'S SEAL, IF APPLICABLE

DUKE/FLUOR DANIEL℠

	INITIALS/DATE
DRAWN BY R. AGUILAR	
CHECKED BY B. CHENG	
INSPECTED BY LAYOUT	
INSPECTED BY SYSTEMS H. REINHART	
INSPECTED BY CSA	
INSPECTED BY ELECTRICAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR T. MUALLEM	

DUKE ENERGY AVENAL, LLC
AVENAL ENERGY PROJECT
AVENAL, CALIFORNIA

FIGURE 2.1-4
SITE PLAN
CONCEPTUAL DESIGN

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
1"=400'	226879	0	PP	5	SP-02	-	G

Plot User USERNAME
Plot Date & Time $$$$DATE$TIME$$$$
MANUAL CHANGES MADE - YES ☐ NO ☐ DWG. FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐
SP02F.DGN

CADD FILE NO. WRK. PKG. DIST. CODE CONTRACT PKG.

DFD_D.DGN 01-22-01

LEGEND:

- SITE PROPERTY LINE
- PROPOSED GAS PIPELINE ROUTE
- ALTERNATE GAS PIPELINE ROUTE
- PROPOSED TRANSMISSION LINE ROUTE
- PROPOSED WATER LINE ROUTE
- EXISTING WATER WELL LOCATION
- FRESNO/KINGS COUNTY LINE
- 350 INDEX ELEVATION CONTOUR
- INTERMEDIATE ELEVATION CONTOUR

0 2,000 4,000 FEET
SCALE

AERIAL PHOTOGRAPH

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY **FIGURE 2.1-5**

The City has determined that location of a power plant conforming to existing environmental laws and regulations is consistent with the industrial zone and would provide additional benefits to the City and other local government entities. The land proposed for development has been used for agriculture since the early 1950s. The Site has historically been used for a number of row crops, including cotton and barley. The surrounding area is cultivated in row crops and orchards (e.g., almonds and oranges).

Development of the Project will result in substantial socioeconomic benefits with minimal environmental impacts, as addressed in the following sections. Additional details of environmental parameters are provided in Chapter 6.0 - Environmental Information. Socioeconomic benefits are detailed in Section 6.10 - Socioeconomics.

2.2.2 ENVIRONMENTAL DESIGN FEATURES

The Project has been located and designed to provide electrical power for California's growing needs, while minimizing environmental impacts of Project development. Key environmental design features include:

- The Project is consistent with City of Avenal land use plans, zoning and other controls, including a variance from the height limit, approved by the Planning Commission and City Council on June 4 and June 14, 2001, respectively.
- The Site is located away from developed urban areas and surrounded by agricultural lands. It is located at the outskirts of the City, in an industrial park.
- The Project is located to ideally use existing industrial infrastructure, including water and gas supplies and electrical transmission lines. Tie-ins to these existing infrastructure systems will be relatively short, so there will be minimal construction-related environmental impacts.
- The Site and infrastructure tie-ins occur on lands that have been extensively disturbed by agricultural activity. No disturbance of natural vegetation or natural habitat will occur.
- The 148-acre Site is more than adequate for the physical plant construction activities (e.g., laydown, staging), provides room for city related facilities and provides a large buffer area between the physical plant and the nearest roadway.
- The Project water supply minimizes potential environmental impacts by avoiding:
  a) Any new diversion of water from the Delta.
  b) Any reduction in agricultural water supply.
  c) Any net increase in groundwater pumping.

- The Project generating unit will be fueled by clean-burning natural gas. Equipment to control emissions to air will be provided in accordance with SJVUAPCD Best Available Control Technology (BACT) requirements. Also, emissions offsets will be obtained in accordance with SJVUAPCD requirements.
- The facility will be designed to minimize water consumption via incorporation of a ZLDF. The ZLDF is a water treatment system that will recover process purge streams, primarily cooling tower blowdown, for treatment and recycling of the process water back to the system. The ZLDF will reduce raw water consumption by approximately 10 percent.
- The Project is designed to recycle process blowdown and other process purge streams with no discharge. This design provides a substantial benefit to water quality compared to plants with conventional wastewater disposal. The no discharge design is possible due to the ZLDF.
- The Site is located almost 2 miles from Interstate 5, and approximately 200 feet lower in elevation than the freeway. The distance and orientation will reduce the visibility of the Project from Interstate 5. There will be no impact to the skyline from Interstate 5 and other areas of the Valley.
- The Project design, construction and operation includes specific features to control the generation of fugitive dust so as not to affect surrounding agricultural operations.
- The Project's landscaping will assure that weedy species are not introduced to the Site or surrounding area.
- Equipment design will include noise attenuation technology that will not only contribute to a safe working environment within the plant, but will also ensure compliance with local noise standards in the surrounding community.
- Biological, cultural, paleontological and other resource evaluations have demonstrated that there are few, if any, sensitive resources on the Site and linear corridors.
- Waste products and hazardous materials will be managed in accordance with environmental and public safety laws and regulations to minimize the potential for impacts to occur.

2.2.3 ENVIRONMENTAL DESIGN BENEFITS

2.2.3.1 Improving Electric Generation Fuel Efficiency

The existing electric generation system in California is aging. Research and development have produced vast improvements in electrical generation technology. Modern technology results in lower production costs and reduced environmental impacts compared to much of the older thermal generating capacity currently serving California's electric customers.

The Project's combined-cycle unit will be substantially more efficient and, overall, will produce substantially less environmental impact compared to existing fossil fuel-fired steam/electric plants or simple-cycle combustion turbine peaking plants in California. The Project's combined-cycle unit will be among the most efficient generators serving the California market. By providing additional efficient generation, the older, less efficient generators elsewhere will not operate as often. New technology in gas turbine materials, combustion processes and exhaust gas treatment reduces emissions and provides increased efficiency and output power. Thus, additional efficient generation will reduce emissions and improve air quality statewide, per unit of power generated.

2.2.3.2 Improving Local Electric Reliability

For nearly a year, California has experienced first-hand the effects of deficiency in electric energy supply. A heat storm caused rolling blackouts in northern California in 2000. In addition, from November 2000 through January 2001 the Independent System Operator (ISO) declared emergency alerts, reflecting low electrical reserve margins.

The Project will be a substantial contributor to meeting the state's energy needs. By supporting local and San Joaquin Valley loads, the Project will improve electric supply reliability in this region. Furthermore, the Project generating capacity will provide additional reactive power capability that will serve to improve area transmission system voltage. The addition of the 600 MW combined-cycle generation module results in more firm generation available for direct local service to the San Joaquin Valley area loads. As local area loads grow, service can be efficiently provided from the Project.

2.2.4 OTHER SOCIOECONOMIC BENEFITS

Construction of the Project will increase state, county and city tax revenues through taxes and fees. Purchase of related equipment and supplies for the Project within the City of Avenal will provide additional sales tax revenues to the City of Avenal and Kings County. Additional economic benefit will be derived from the general spending provided from construction worker payrolls, purchasing and related spending. Duke Avenal estimates that the additional property taxes paid by Duke Avenal will be approximately $3.25 million per year. Under recent State

Board of Equalization decisions, property taxes from the Project will be collected and distributed by Kings County. It is expected that the City of Avenal will receive over $600,000 per year of property taxes paid by Duke Avenal through the Kings County tax collector's office. Additionally, during Project construction, Duke Avenal expects to purchase an estimated $1.5 million of equipment and materials locally, which will benefit local businesses. Gas franchise fees paid by Duke Avenal also will benefit the local area.

Project construction is expected to last 20 months and employ an average of 240 people per month. In addition to providing the highly paid construction positions, the work force will create indirect jobs in other service areas, thereby providing further employment. Project operations will increase the current level of employment in Avenal by approximately 30 full-time permanent positions. This includes management, supervisory and International Brotherhood of Electrical Workers (I.B.E.W.) represented operations and technical craft employees.

Socioeconomic benefits of the Project are detailed in Section 6.10.

2.3 GENERATION FACILITY DESCRIPTION, DESIGN AND OPERATION

The following sections describe power generation selection, facility layout, facility engineering design, process description (including process flow diagrams with heat and material balances, major equipment and ancillary systems), civil/structural features, and construction and operation activities that constitute the Project. The Project will be designed, constructed and operated in accordance with applicable LORS. In addition, the generation facilities will be designed and constructed in accordance with the design criteria provided in Appendices 2-1 through 2-5.

2.3.1 SITE AND FACILITY SELECTION CONSIDERATIONS

Duke Avenal selected the Site for the Project after careful consideration of California's need for additional generating capacity, potential available sites and infrastructure tie-ins, and an extensive review of environmental conditions at the Site that will minimize Project impacts. Key Site considerations include the following:

- **Location**. The Site is ideally located to utilize existing infrastructure, including natural gas supply lines, electrical transmission lines and water supply. Short interconnections to existing systems are required. Interconnections are located on disturbed lands, so construction and operation of linear facilities can be completed without impacting natural habitat and with minimal impact to other resources.

- **Power generation is consistent with local plans**. The Project is compatible with land use plans for the City of Avenal and Kings County. Locating the combined-cycle unit in Avenal, compared to another location, is consistent with the City's industrial zoning and industrial park development.
- **Environmental impacts are minimized**. The parcel selected has historically been used for a variety of row crops, such as cotton and barley. Other parcels in the area are being cultivated for row crops and tree crops, such as almonds and oranges. Given the existing intensive agricultural setting, and the approximately 50 years that the area has been farmed, Project construction and operation will not impact any natural habitat. Due to the Site characteristics and Project design features, there will be no significant impacts in the areas of biological resources, water resources, air resources, land use, agriculture and soils, geologic resources and hazards, transportation, hazardous materials, waste management, worker safety, transmission line safety, public health, cultural resources, paleontological resources, visual resources or noise.
- **Visual design measures**. Duke Avenal has paid particular attention to locating and designing the Site and facilities to enhance the City's industrial park area with minimal affect to views from surrounding lands. The Site is located away from both Interstate 5 and the commercial and residential community of the City of Avenal. In addition, landscaping will further screen the Project from offsite areas, and has been designed in consultation with the City to help achieve the visual enhancement desired by the City.
- **Benefit to the public**. The Project will provide power with minimal environmental impacts. Construction and operation of the Project will increase state, county and city tax revenues through taxes and fees. Employment will be created and secondary benefits will occur due to money spent locally for goods and services and payroll. The Project will provide high-paying jobs in an area that has an unemployment rate substantially higher than the state average (see Section 6.10). These jobs will help to diversify the employment and economic base in the local area and region.

Based on these considerations, Duke Avenal has proposed development of the Project at the Site.

Further discussion of Site selection and alternative power generating technologies and other systems is included in Chapter 5.0 - Alternatives Analysis. Detailed evaluations of existing environmental conditions and potential environmental impacts are provided in Chapter 6.0 - Environmental Information.

2.3.2 OVERVIEW OF FACILITIES

The Project is referred to as a "combined-cycle" plant because it will utilize natural gas-fired CTGs combined with exhaust heat recovery to power a STG. This combined-cycle technology is more efficient than older fossil fuel-fired steam/electric plants or simple-cycle combustion turbine peaking plants that are typical of many power plants in California's aging power infrastructure. Compared to older technology plants, the increased efficiency of the Project technology results in reduced fuel consumption, reduced emissions and reduced generating cost per unit of power generated.

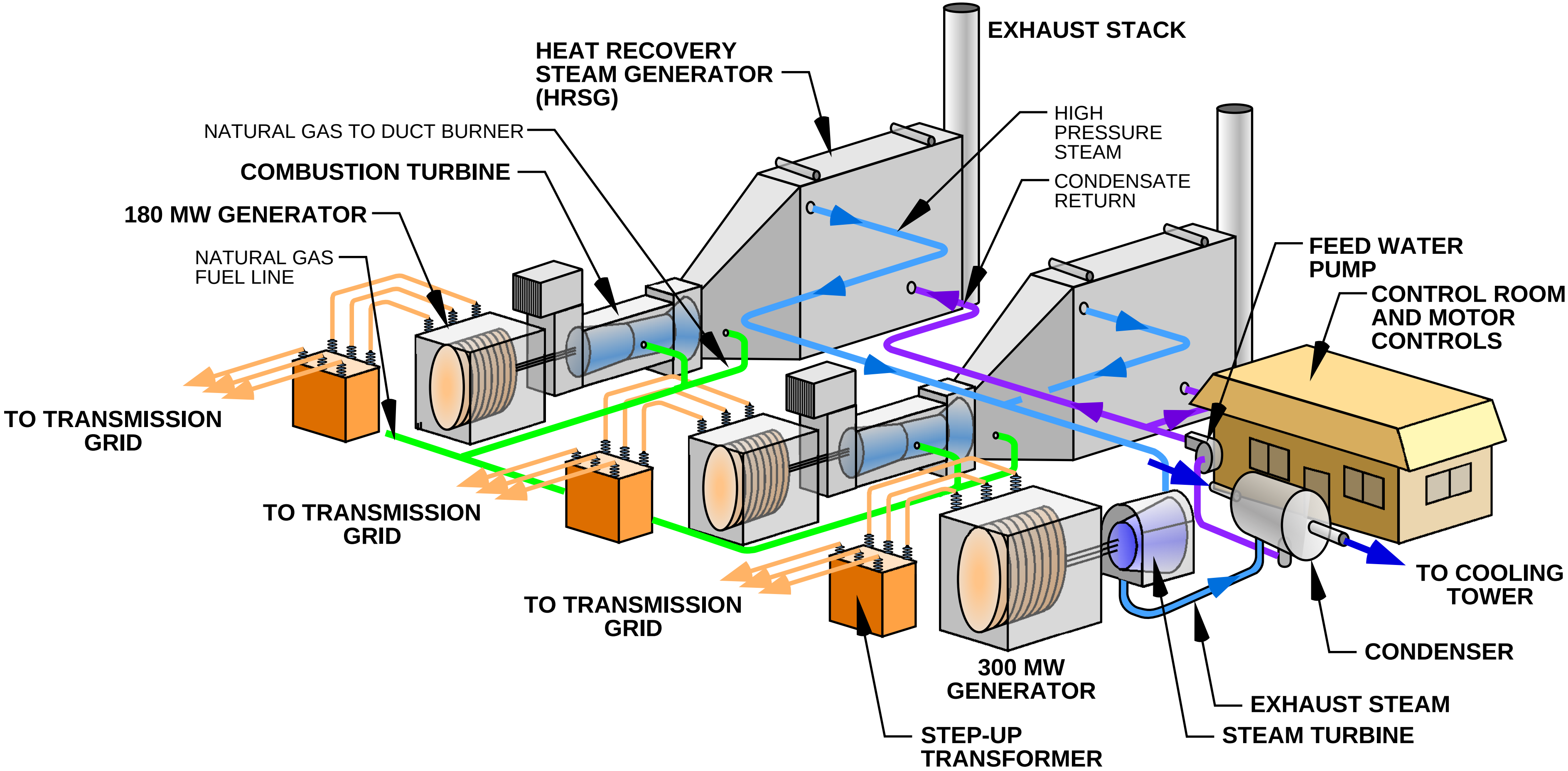
The Project power generating unit (the "power block") will consist of two CTGs, each with an associated HRSG. The two HRSGs will recover heat from the CTG exhaust gases to produce steam that will power one STG. The configuration of two CTG/HRSG sets with one STG is referred to as a "two-on-one" configuration. Equipment and process schematics of the power block are provided in Figures 2.3-1 and 2.3-2.

The CTGs are designed with dry low NO_x (DLN) combustors and are equipped with mechanical inlet-air chillers to cool inlet air for increased efficiency during hot weather. The HRSGs will be equipped with duct burners that will utilize natural gas as fuel to increase steam generation at times of peak demand. With the duct burners and inlet mechanical chillers in service and the CTGs at full load, the HRSGs produce sufficient steam to operate the STG close to its full rated capacity.

Other major ancillary facilities include a mechanical draft cooling tower, a water-cooled surface condenser, emissions control equipment, plus ZLDF for removing salts from process blowdown.

Major Project components include:

- Power Block.
  - Two combustion turbine generators
  - Two heat recovery steam generators
  - Steam turbine generator and water-cooled condenser
- Balance of the Plant (BOP) and Infrastructure.
  - Mechanical draft cooling tower
  - Raw water softener clarifier and storage system
  - ZLDF
  - Electro-deionization (EDI)/mixed-bed polisher demineralized water system
  - Administrative and control buildings
- Installation of new raw water pipelines to the City of Avenal water turnout and from the existing agricultural wells that will be used for a backup water supply.

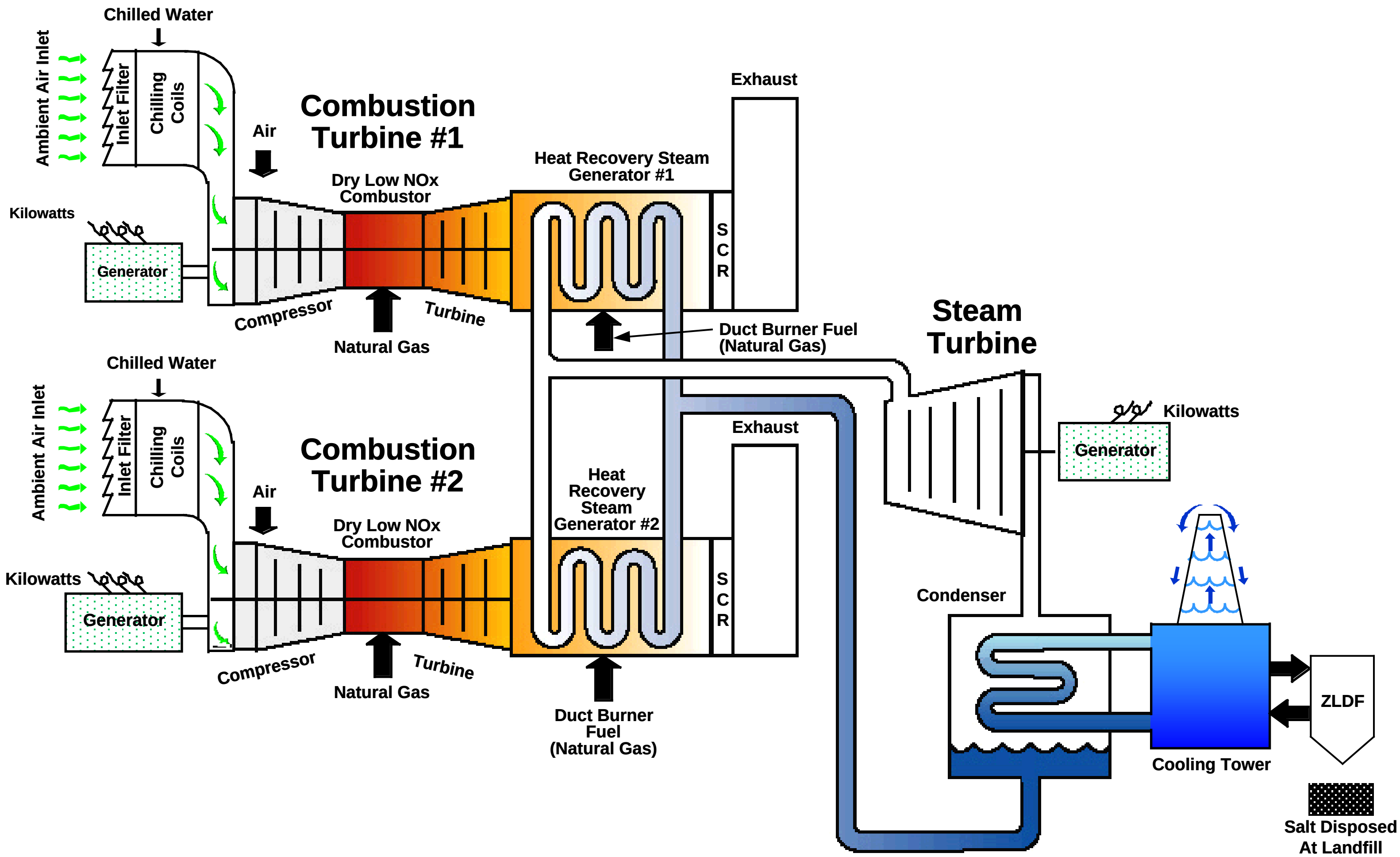


SOURCE: DUKE ENERGY, 2000.

EQUIPMENT SCHEMATIC
600 MW COMBINED-CYCLE UNIT

DUKE ENERGY AVENAL LLC

AVENAL ENERGY	FIGURE 2.3-1



SOURCE: DUKE ENERGY, 2001.

PROCESS SCHEMATIC
600 MW COMBINED-CYCLE UNIT

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	**FIGURE 2.3-2**

- Installation of an onsite switchyard and a short, 230-kV transmission line to loop the existing PG&E line into the Project.
- Installation of a gas pipeline tie-in to the PG&E Kettleman compressor station.
- Improvement of access to the Site from Avenal Cutoff Road.

2.3.3 FACILITY LAYOUT

Site layout drawings, including a plot plan, elevation view, and an isometric view of the Project, are provided in Figures 2.3-3, 2.3-4 and 2.3-5, respectively. Construction and operation, including laydown, will occur entirely within the Site, with the exception of easements for natural gas, electric transmission and water linear facilities.

Laydown and construction activities will encompass a portion of the Site as described in Section 2.3.18.11. Once construction is complete, Project facilities, including the power generation facility, switchyard and storm water retention basin, will occupy approximately 25 acres. The majority of Project facilities are situated in the southeast portion of the Site, where they are farthest from Avenal Cutoff Road. Much of the property will remain in agricultural production during construction and following commercial operations. The plant's visual appearance, prior to and following construction, is provided in the detailed visual analysis in Section 6.13 - Visual Resource Analysis.

2.3.4 FACILITY DESIGN

The following sections discuss the design of the combined-cycle unit. Additional technical details and design criteria for the Project can be found in the following Appendices:

- Appendix 2-1 - Civil Engineering Design Criteria
- Appendix 2-2 - Structural Engineering Design Criteria
- Appendix 2-3 - Mechanical Engineering Design Criteria
- Appendix 2-4 - Electrical Engineering Design Criteria
- Appendix 2-5 - Control Systems Engineering Design Criteria
- Appendix 2-6 - Process Flow Diagrams With Heat and Material Balances, Plant Performance
- Appendix 2-7 - Major Equipment List
- Appendix 2-8 - Water Balance Diagram and Analyses

2.3.5 PROCESS DESCRIPTION

This section provides a description of the power generation process and thermodynamic cycle that will be employed by the Project.

2.3.5.1 Power Generation Overview

The Project, employing combined-cycle technology, will produce power from:

- The combustion of natural gas to provide thermal energy that a combustion turbine converts into mechanical energy, driving an electric generator.
- The additional use of heat from the combustion turbine exhaust gas that is recovered in an Heat Recovery Steam Generator (HRSG) to produce steam, which expands within a steam turbine, driving an electric generator.
- Additional peak load capacity generated by the steam turbine when natural gas is duct-fired in the HRSGs to create more steam.

The Project's natural-gas-fired combined-cycle unit is designed to deliver a net output of 600 MW; supplemental duct firing shall be utilized, when needed, to peak at 600 MW. With the inlet-air mechanical chillers in service, each of the two CTGs will generate approximately 172.6 MW of gross power at 97°F ambient temperature. All of the steam exiting the HRSGs will be directed to the STG, which will generate approximately 180 MW of gross power. The overall gross output of the power plant is 525 MW at this condition. With the HRSG duct burners in service, the STG will generate 283 MW, while the power plant will produce approximately 628 MW of gross[2] power.

2.3.5.2 Power Generation Thermodynamic Cycle

Thermodynamically, the combined-cycle is a combination of two cycles: the Brayton cycle (the gas turbine cycle) and the Rankine cycle (the steam turbine cycle).

The thermodynamic cycle whereby air is compressed, heated for combustion of a fuel and expanded to produce useful work is the Brayton cycle. Air flows through the CTG inlet air filter, mechanical chillers and associated ductwork to the CTG compressor section. The compressed air from the compressor section flows to the CTG combustor section where it is mixed with compressed natural gas and ignited. The hot combustion gases flow through the CTG turbine expander section, which drives both the CTG compressor section and electric generator.

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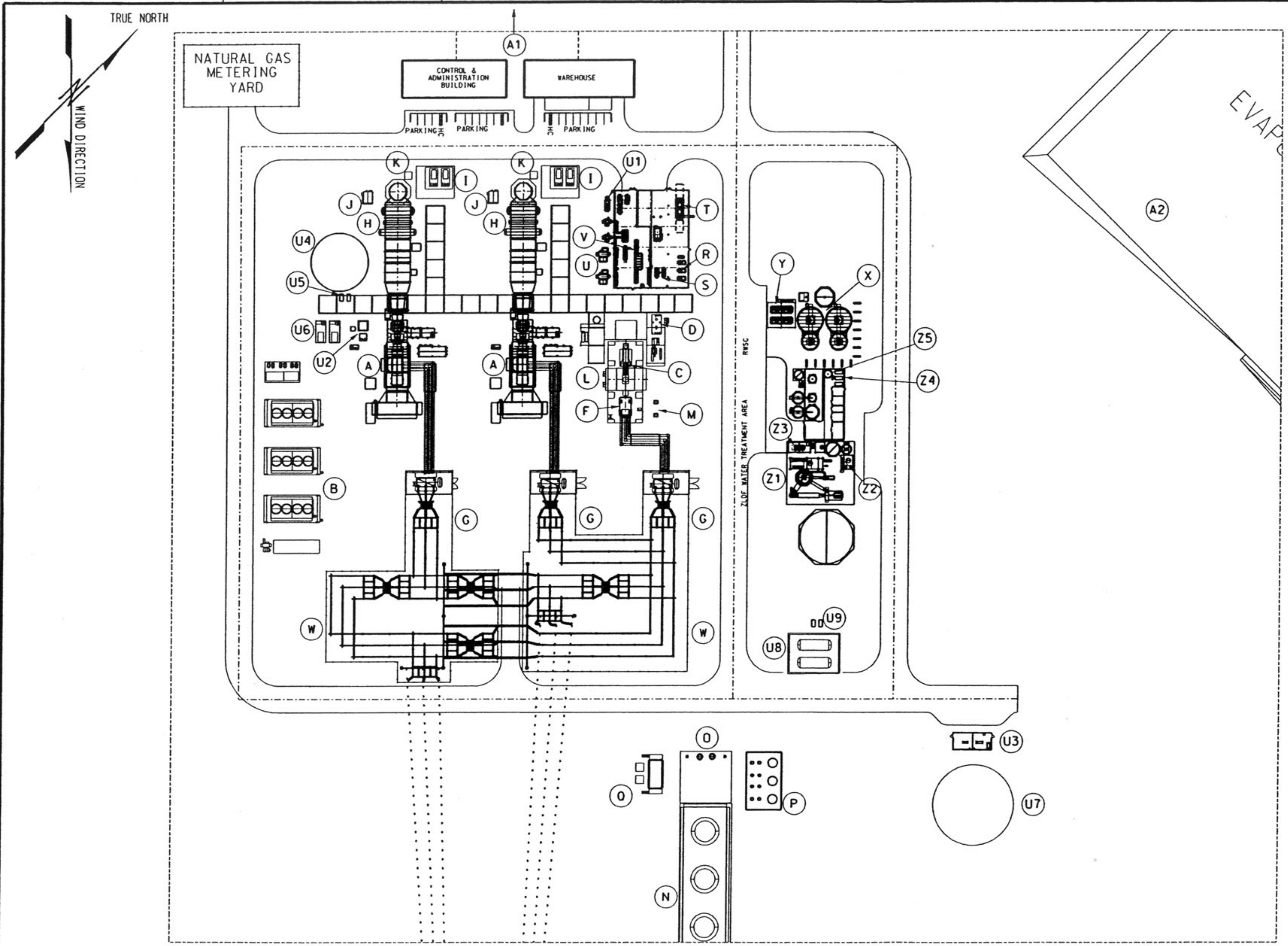
(2) 600 megawatts is the nominal net power output and is used to describe the output of the Avenal Energy Project throughout this document.



MAJOR EQUIPMENT LIST

A GAS TURBINE GENERATOR
B INLET AIR CHILLERS (W/AUXILIARY COOLING TOWERS)
C STEAM TURBINE
D STG LUBE OIL SKID
E DELETED
F STG GENERATOR
G MAIN TRANSFORMERS
H HEAT RECOVERY STEAM GENERATOR
I HP/IP BOILER FEED WATER PUMPS
J CONTINUOUS EMISSIONS MONITORING SYSTEM
K HRSG BLOWDOWN SUMP
L SURFACE CONDENSER
M CONDENSATE PUMPS
N PLANT COOLING TOWER
O CIRCULATING COOLING WATER PUMPS
P COOLING WATER CHEMICAL INJECTION SYSTEMS
Q POWER DISTRIBUTION CENTER
R CLOSED-LOOP COOLING WATER EXCHANGERS
S CLOSED-LOOP COOLING PUMPS
T AUXILIARY BOILER
U AUXILIARY TRANSFORMER
V AUXILIARY SUBSTATION
W SWITCHYARD
X RAW WATER SOFTENER CLARIFIERS (RWSC)
Y RWSC FILTER PRESS
Z ZERO LIQUID DISCHARGE FACILITY (ZLDF)
Z1 BRINE CONCENTRATOR (EVAPORATOR)
Z2 CRYSTALLIZER
Z3 FILTER PRESS
Z4 EDI UNIT
Z5 MIXED-BED POLISHER

A1 SEPTIC TANK & LEACH FIELD (IMMEDIATELY NW)
A2 STORM WATER EVAPORATION/PERCOLATION BASIN

UTILITIES

U1 BACKUP DIESEL GENERATOR
U2 OIL/WATER SEPARATOR
U3 FIREWATER PUMP HOUSE
U4 DEMINERALIZED WATER STORAGE TANK
U5 DEMINERALIZED WATER PUMPS
U6 PLANT/INSTRUMENT AIR COMPRESSORS
U7 RAW WATER/FIREWATER STORAGE TANKS
U8 AMMONIA STORAGE TANKS
U9 AMMONIA TRANSFER PUMPS

0' 25' 50' 75' 100' 150'
REDUCED PRINT SCALE

REV.	DATE	REVISION DESCRIPTION	DRWN CHK.
A	06-07-01	PRELIMINARY PLOT PLAN	RA
B	06-22-01	ISSUED FOR AIR MODELING	BC
C	07-06-01	UPDATED PER LATEST SITE PLAN	BC
D	07-26-01	REVISED WATER TANK & FIREWATER PUMPS	TQ
E	07-26-01	RELOCATED FIREWATER PUMP HOUSE & RAW WATER/FIREWATER STORAGE TANKS	BN
F	08-23-01	UPDATED PER LATEST DESI TRANSMISSION LINE	BC

DWG.NO. — REFERENCE DRAWINGS — RESERVED FOR PROFESSIONAL ENGINEER'S SEAL, IF APPLICABLE

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ENGINEERING MANAGER
PROJECT DIRECTOR T. MUALLEM

DUKE ENERGY AVENAL, LLC
AVENAL ENERGY PROJECT
AVENAL, CALIFORNIA

FIGURE 2.3-3
PLOT PLAN
CONCEPTUAL DESIGN

SCALE 1"=125' — PROJECT NUMBER 226879 — UNIT No 0 — DOC TYPE PP — FUNC 5 — SEQ No 01 — REV. F

Plot User USERNAME — Plot Date & Time $$$$DATE$TIME$$$$ — MANUAL CHANGES MADE - YES ☐ NO ☐ — DWG. FILE UPDATED - YES ☐ NO ☐ — MODEL UPDATED - YES ☐ NO ☐ — PLOT01e.DGN

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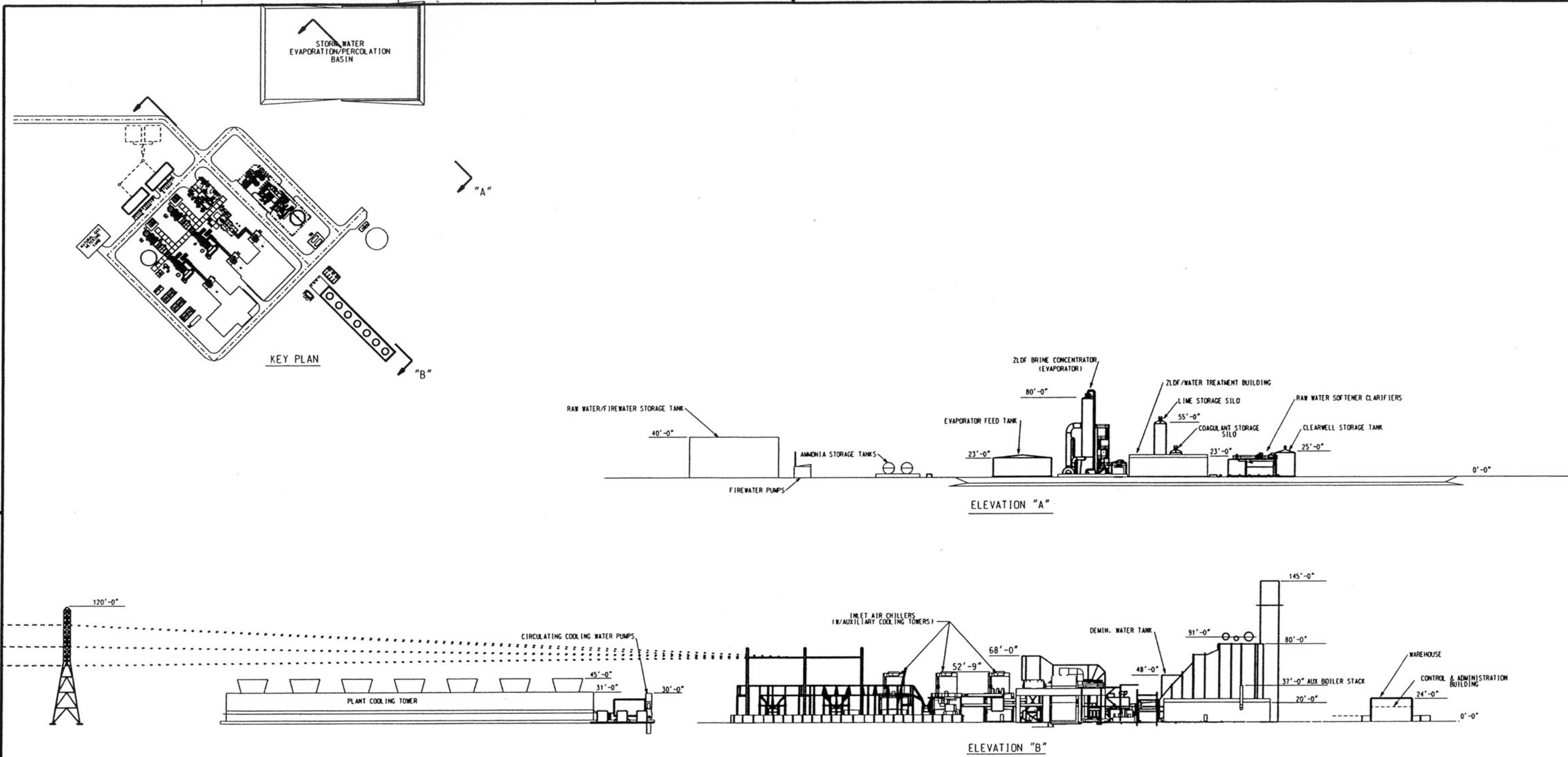

REV.	DATE	REVISION DESCRIPTION	DRWN CHK.	LAYO SYS	CSA ELEC	ENGM PROJ
A	06-11-01	ISSUED FOR REVIEW	BC			
B	06-19-01	REVISED PER NEW TOPO DWG FM TRC & NEW TRANSMISSION LINE DWG FM DESI	BC			
C	06-22-01	ISSUED FOR AIR MODELING	BC			
D	07-26-01	REVISED WATER TANK & FIREWATER PUMPS	TQ			
E	07-26-01	RELOCATED FIREWATER PUMP HOUSE & RAW WATER/FIREWATER STORAGE TANKS	BN			
F	08-13-01	CHANGED HRSG STACK HIGH FROM 160' TO 145'	BC			

DWG.NO.	REFERENCE DRAWINGS

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INSPECTED BY ELECTRICAL	
ENGINEERING MANAGER: T. MUALLEM	
PROJECT DIRECTOR	

DUKE ENERGY AVENAL, LLC
AVENAL ENERGY PROJECT
AVENAL, CALIFORNIA

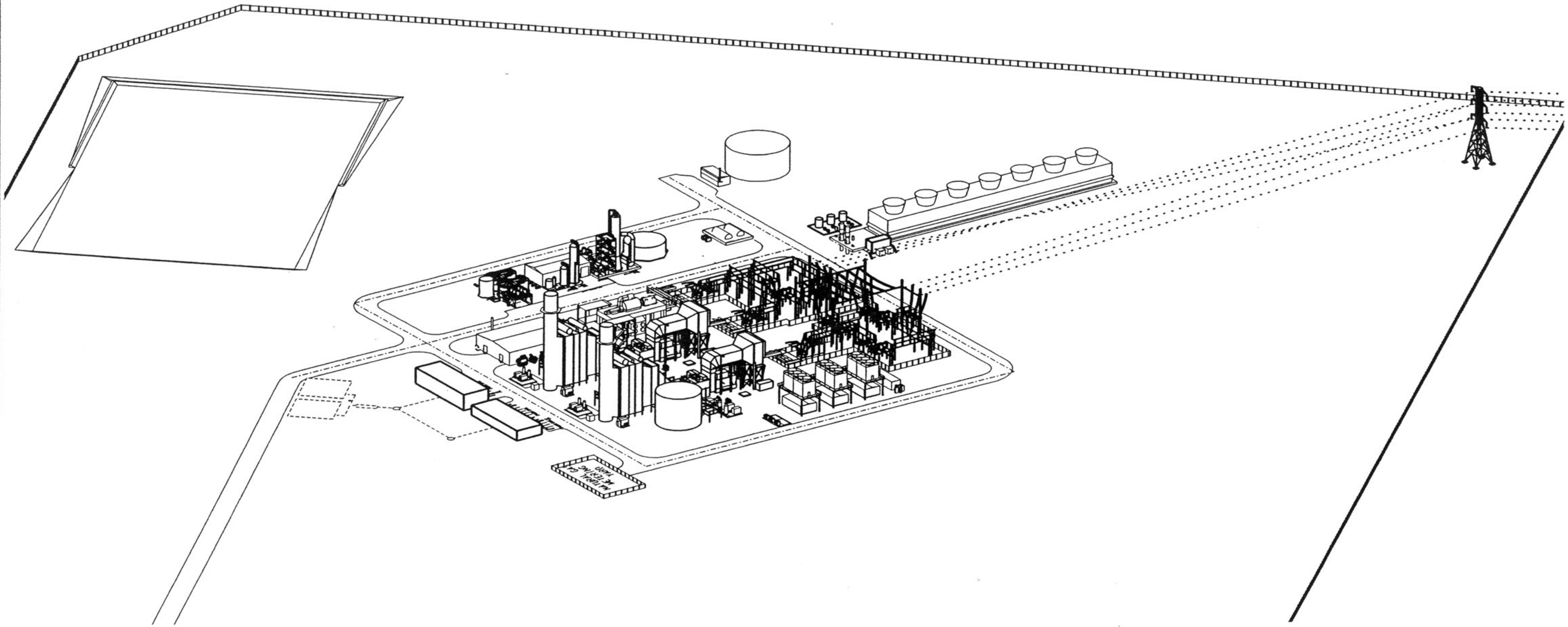
FIGURE 2.3-4
ELEVATION VIEW
CONCEPTUAL DESIGN

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
NONE	226879	0	PP	5	EL-01		E

Plot User USERNAME
Plot Date & Time $$$$DATE$TIME$$$$
MANUAL CHANGES MADE - YES ☐ NO ☐   DWG. FILE UPDATED - YES ☐ NO ☐   MODEL UPDATED - YES ☐ NO ☐
EL01E.DGN

CONTRACT PKG. CADD FILE NO. WRK. PKG. DIST. CODE

01-22-01 DFD_0.DGN



REV.	DATE	REVISION DESCRIPTION	DRWN / CHK.	LAYO / SYS	CSA / ELEC	ENGM / PROJ	DWG.NO.	REFERENCE DRAWINGS
B	06-19-01	PRELIMINARY PLOT PLAN - ISOMETRIC VIEW	RA					
C	06-22-01	ISSUED FOR AIR MODELING	BC					
D	07-18-01	UPDATED PER LATEST SITE PLAN	BC					
E	07-26-01	REVISED WATER TANK & FIREWATER PUMPS	TO					
F	07-26-01	RELOCATED FIREWATER PUMP HOUSE & RAW WATER/FIREWATER STORAGE TANKS	BN					

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INSPECTED BY CSA	
INSPECTED BY ELECTRICAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR T. MUALLEM	

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AVENAL, CALIFORNIA

FIGURE 2.3-5
ISOMETRIC VIEW
CONCEPTUAL DESIGN

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
NONE	226879	0	PP	5	IS-01	01	G

Plot User USERNAME
Plot Date & Time $$$$DATE$TIME$$$$

MANUAL CHANGES MADE - YES ☐ NO ☐ DWG. FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

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Thermal efficiency is improved in combined cycles, which recover waste heat from the combustion turbine exhaust by means of a waste heat boiler or HRSG. The second thermodynamic cycle, where additional energy is recovered from the hot CTG exhaust gas, is called the Rankine cycle. The combustion gases exit the turbine expander section and enter the inlet duct of the HRSG which is equipped with duct burners. When fired, the burners additionally heat the exhaust gases that then enter the HRSG steam generation section. In the HRSG steam generation section, heat from the combustion gases is transferred to water pumped through the HRSG steam generation components (economizers, evaporators, drums, superheaters, etc.). The water is converted to steam at three pressures: high pressure (HP), intermediate pressure (IP), and low pressure (LP), then superheated and delivered to the STG. The HP steam, admitted to the HP section of the STG, expands through the HP section and exits the HP section as "cold" reheat steam. The "cold" reheat steam is combined with superheated IP steam and returned to the reheater section of the HRSG where it is reheated and returned to the STG, continuing its expansion and driving the generator. Reheating the IP steam improves the overall steam cycle efficiency. Exhaust steam from the STG enters a surface condenser, where it is condensed into water and recycled back to the HRSG as boiler feed water, thereby completing the steam cycle.

The advantage of combining these two thermodynamic cycles into a "combined-cycle" plant or unit is that the major losses of the Brayton cycle (stack losses) are recovered for use in the Rankine cycle. In turn, the major loss of the Rankine cycle, the condenser heat rejection, is diminished since the steam cycle is only part of the total combined cycle or combustion turbine fuel input.

2.3.6 COMBINED-CYCLE UNIT CTGs, HRSGs, AND STG

This section describes the major components and systems of the Project: the CTGs, HRSGs, STG, and the Heat Rejection (Cooling) System. A listing of major equipment is provided in Appendix 2-7.

2.3.6.1 Combustion Turbine-Generators (CTGs)

The combined-cycle unit includes two advanced natural-gas-fired model PG7241 "7FA" class CTGs supplied by General Electric (GE) Power Systems. Each CTG will consist of a heavy duty, single-shaft, combustion turbine-generator and associated auxiliary equipment.

The CTGs will be equipped with DLN combustors designed for natural gas and inlet-air mechanical chillers to enhance output at higher ambient temperatures. The CTGs will be capable of delivering electric power in continuous operation and will be equipped with the following accessories required to provide efficient, safe and reliable operation:

- Inlet air filters and on-line filter cleaning system
- Inlet air mechanical chiller system
- On-line and off-line compressor wash system
- Metal acoustical enclosures
- Fire detection and protection system
- Lubrication oil system, including oil coolers and filters
- Generator coolers
- Starting system, auxiliary power system and control system
- Exhaust system
- Gas fuel system
- Surge protection equipment
- Potential transformer cubicle

Combustion turbine output and efficiency both increase as inlet air temperature decreases. Ambient air temperatures for the Project are sufficiently high for a large portion of the year to warrant some form of inlet air cooling. Air chilling is capable of cooling CTG inlet air to temperatures significantly below the ambient wet-bulb temperatures (chilled air temperature is typically 45°F) over a wide range of ambient conditions. Air chilling uses mechanical or absorption refrigeration to produce a cold fluid for cooling of the inlet air.

Based on temperature profiles at the Site, CTG mechanical inlet chilling was selected to enhance capacity at high ambient temperature conditions.

2.3.6.2 Heat Recovery Steam Generators (HRSGs)

With the Project's two-on-one configuration, hot exhaust gas from each combustion turbine will flow to a dedicated HRSG. The HRSGs provide for the transfer of heat from the CTG exhaust gases to condensate and feedwater to produce steam. Each HRSG will be approximately 90 feet high and will have an exhaust stack approximately 145 feet tall by 19 feet in diameter. The size and shape of the HRSGs are specific to their intended purpose of high efficiency recycling of waste heat from the CTG.

The HRSGs will be multi-pressure, natural-circulation boilers equipped with transition ducts and duct burners. Pressure components of each HRSG include an LP economizer, LP evaporator, deaerator/LP drum, LP superheater, IP economizer, IP evaporator, IP drum, IP superheater, HP economizer, HP evaporator, HP drum, HP superheater and reheaters.

Superheated HP steam is produced in the HRSG and flows to the steam turbine throttle inlet. The exhausted cold reheat steam from the steam turbine is mixed with IP steam from the HRSG and reintroduced into the HRSG through the reheaters. The hot reheat steam flows back from the HRSG into the STG. The LP superheated steam from the HRSG is admitted to the LP sections of the STG. Steam that is exhausted from the STG is condensed in a water-cooled condenser. The condensate is pumped from the condenser back to the HRSG by condensate pumps. The condensate is preheated by an HRSG feedwater heater. Boiler feedwater pumps send the feedwater through economizers and into the boiler drums of the HRSG, where steam is produced, thereby completing the steam cycle.

Duct burners are installed in the HRSG transition duct between the HP superheater and reheat coils. Through the combustion of natural gas, the duct burners heat the CTG exhaust gases to generate additional steam at times when peak power is needed. The duct burners are also used as needed to control the temperature of steam produced by the HRSGs.

Each HRSG is equipped with a SCR system that uses aqueous ammonia in conjunction with a catalyst bed to reduce NO_x in the CTG exhaust gases. The catalyst bed is contained in a catalyst chamber located within each HRSG. Ammonia is injected upstream of the catalyst bed. The subsequent catalytic reaction converts NO_x to nitrogen and water, resulting in a reduced concentration of NO_x in exhaust gases exiting the stack.

An oxidation catalyst located within each HRSG reduces the concentration of CO in exhaust gases exiting the stack. The oxidation catalyst also reduces the concentration of VOC emissions.

2.3.6.3 Steam Turbine-Generator (STG)

The STG system includes a reheat steam turbine-generator, governor system, steam admission system, gland steam system, lubrication oil system, including oil coolers and filters, and generator coolers.

Steam from the HP superheater, reheater and IP superheater sections of the HRSG enters the corresponding sections of the STG as described previously. The steam expands through the turbine blading to drive the steam turbine and its generator. Upon exiting the turbine, the steam enters the deaerating condenser, where it is condensed to water.

2.3.6.4 Cooling System for Heat Rejection

The heat rejection system of the steam cycle consists of a surface condenser, circulating water system and wet cooling tower. The surface condenser receives exhaust steam from the LP section of the STG and condenses it to liquid for return to the HRSGs. The surface condenser is a shell-and-tube heat exchanger with wet, saturated steam condensing on the shell side and circulating water flowing through the tubes to provide cooling. The shell side of the condenser is designed to operate under a vacuum, with an absolute pressure of 3.6 inches of mercury (in HgA) at hot summer day ambient conditions. At this condition, approximately 1.66 million pounds per hour of wet, saturated steam is condensed, resulting in a heat rejection rate of 1,567 million British thermal units (Btu) per hour. This heat is absorbed by approximately 105,150 gallons per minute (gpm) of circulating water that exits the condenser 29°F warmer than when it entered.

The warm circulating water from the surface condenser and other cooling water uses in the plant are directed to a plant mechanical draft cooling tower, approximately 400 feet long by 50 feet wide by 45 feet high, consisting of air-to-water contact surfaces (fills) and electric motor-driven fans. The warm circulating water is distributed among multiple cells of the plant cooling tower, cascading from the top, through the tower, where it contacts a high airflow drawn through the tower by fans. Cooling occurs primarily through partial evaporation of the falling water (similar to the operation of a "swamp" cooler) and contact cooling of the water by the cooler air. The cooled water collects in a large collecting basin beneath the tower where cooling water circulation pumps return the water back to the condenser and other equipment users to repeat the cycle.

Recirculating water is lost from the process principally in three ways: evaporation from the tower, a "blowdown" (purge) stream and minor drift loss. Evaporation from the cooling tower constitutes the main loss of water for the Project. As water evaporates in the cooling tower, the total dissolved solids (TDS) increase. At excessive levels, these solids could precipitate on the cooling tower heat transfer surfaces. The resulting scale on these surfaces would increase the resistance to the transfer of heat and degrade the performance of the cooling tower. To counteract these effects, a portion of the basin water must be continuously removed and processed as cooling tower blowdown. A third minor loss consists of liquid water droplets (drift) entrained with the air and water vapor leaving the top of the cooling tower. The evaporation, blowdown and drift losses must be replenished by adding replacement ("makeup") water to the system.

A separate circulating cooling water system will be utilized for the CTG inlet air mechanical chillers. The CTG inlet air chilling system consists of three parallel refrigeration modules with a total refrigeration capacity of 9,814 tons. The system is designed to be comprised of all refrigeration equipment required to chill CTG inlet air to a 45°F dry bulb, including chillers, distribution pumps, cooling tower pumps and modular cooling towers. The system uses HFC 134A as the refrigerant and 25-wt percent ethylene glycol-water as the chilled water which normally is supplied at 38°F and 7,800 gpm per CTG for cooling the CTG inlet air. The chiller system includes dedicated, factory-packaged auxiliary cooling towers that are mounted above each chiller module and have a combined circulation rate of 29,442 gpm. As in the plant cooling tower, a small amount of evaporation, blowdown and drift losses from the modular cooling towers must be replenished by adding makeup water to the system.

2.3.7 WATER SUPPLY AND TREATMENT

This section provides details of estimated consumptive water use by the Project, as well as its source, management strategy, quality and proposed water treatment systems. The various water uses include makeup for the circulating water system, boiler feedwater makeup for the HRSGs, makeup for the service water system and potable water makeup. A water balance diagram is presented in Appendix 2-8.

2.3.7.1 Raw Water Source, Strategy and Quality

The Project will employ a diversified water management strategy to ensure plant reliability and water conservation. The primary source of raw water for the Project will be a surface water supply delivered via the San Luis Canal. The KCWA will provide local water by exchange for the Project in an amount sufficient to meet the estimated annual average and maximum daily water demand for the Project (see Section 2.3.7.2). This surface water supply is adequate for the Project's future operation projections at base load and with peak supplemental duct firing in the HRSGs. The primary water supply will be delivered via a short pipeline from the City of Avenal water turnout to the Project's power block.

A backup source of raw water for the Project will be groundwater from nearby agricultural wells. The backup groundwater supply will be used only under limited circumstances, such as times of interrupted canal flows, events of elevated canal turbidity, or years of much higher than average power demand. The farmer/landowner supplying the backup groundwater owns over 2,000 acres of active orchard and row crop agricultural land surrounding the Project, and will employ conservation measures to reduce groundwater use so there will be no net increase in groundwater pumping. Delivery of the Project's backup source of groundwater from agricultural wells located in the adjacent fields will be via underground pipelines (see Figure 2.1-5).

An onsite raw water/firewater storage tank also will be provided on the Site for backup supply in the event that water sources are temporarily interrupted or water quality is temporarily degraded. The combined surface water and groundwater supply sources and the onsite storage capacity will allow water to be managed to maximize reliability and reduce peak raw water intake rates. The design includes up to 2,000,000 gallons of onsite water storage. This quantity is sufficient to cover a 9-hour interruption of water supplied to the power plant at summer peak conditions. In addition, 240,000 gallons of the raw water in the storage tank will be dedicated to the fire protection water system.

An in-line softener clarifier system will process the supplied raw water and remove suspended solids to an acceptable level. The softened, clarified water will be pumped into a header to supply makeup to the circulating (cooling) water system and additional noncooling water for plant process needs. Noncooling water requirements will include makeup to the HRSG, general service water and stored firewater. A key component and costly upgrade for the Project is the addition of a ZLDF. The ZLDF is a water treatment system that recovers process water purge streams, primarily cooling tower blowdown, and eliminates process water discharge. The ZLDF recycles the process water as purified distillate back to the steam cycle and/or to the cooling tower as makeup, making the plant a "zero" effluent facility. The recycling of process water by the ZLDF reduces Project water consumption by approximately 10 percent.

2.3.7.2 Water Consumptive Requirements

The daily and annual water consumptive requirements for the Project are summarized in Table 2.3-1.

TABLE 2.3-1

DAILY AND ANNUAL AVERAGE CONSUMPTIVE WATER USE

WATER SERVICE/USE	ANNUAL USE(1)	AVERAGE DAILY USE(2)	MAXIMUM DAILY USE(3)
Clarified Water to Plant Cooling Tower Makeup(4)	2,149 AFY	1,332 gpm	2,869 gpm
Clarified Water to Auxiliary Cooling Towers Makeup(4)	80 AFY	50 gpm	261 gpm
Clarified Water to Service Water System	14 AFY	9 gpm	13 gpm
City of Avenal Water to Potable Water System	3 AFY	2 gpm	3 gpm
TOTAL Plant Water Usage Requirements(4)	**2,246 AFY**	**1,393 gpm**	**3,146 gpm**

(1) Annual Use requirements are estimated from weighted daily requirements and plant operations at expected load conditions based on continuous plant consumption at average annual operating conditions of 63°F and 54 percent relative humidity unfired, using a capacity factor of 80 percent with 25 percent duct firing assuming 8,000 hours of plant availability. Both CTG inlet air mechanical chillers are in service.

(2) Average Daily Use requirements are the Annual Use requirements converted to an average daily value.

(3) Maximum Daily Use requirements are based on water consumption at hot summer operating conditions of 97°F and 23.7 percent relative humidity. Both CTG inlet air mechanical chillers are in service with supplemental duct firing in the HRSGs.

(4) Includes credit for recycled high purity distillate from ZLDF, lowering raw water makeup and providing demineralized water makeup demand as outlined in the water balance diagram and water balances in Appendix 2-8.

Water balances in Appendix 2-8 provide the estimated daily continuous water flow rates in gpm. Further analysis of water supply, management strategy, use and impacts is provided in Section 6.5 - Water Resources.

2.3.7.3 Water Treatment

Pre-treatment of raw makeup water for the Project consists of chlorine disinfection, clarification by lime softening, and clear well storage. Filtration will be provided for service water use and firewater. Process flow diagrams in Appendix 2-6 and the water balance diagram in Appendix 2-8 present the interconnections of the plant water systems.

A raw water softener clarifier (RWSC) system will be installed to clarify and soften the raw water makeup. Hydrated lime and soda ash will be added to reduce the hardness associated with alkalinity. In addition, a coagulant and polymer will be added to reduce the level of total suspended solids (TSS) in the raw water. This pre-treatment will help maximize cooling tower cycles of concentration and provide suitable quality feedwater for the service water and firewater. The sludge produced by the softener clarifier(s) is sent to common sludge dewatering equipment. The resultant dewatered sludge will be trucked offsite for disposal in a local nonhazardous landfill.

The ZLDF is a two-stage process: a brine concentrator (evaporator) and a salt-cake crystallizer. The ZLDF treats salty process blowdown by separating the water from the dissolved solids, then recycles purified distilled water (distillate). Typically, over 95 percent of process blowdown can be recovered as high purity distillate. The remaining 5 percent of concentrated brine slurry is continuously withdrawn from the evaporator to a forced-circulation crystallizer to reduce the waste to dry solids (<10 percent moisture). The resultant dewatered salt cake will be trucked offsite for disposal in a local nonhazardous landfill. An estimated composition of the salt-cake is provided in Table 2.3-2. The ZLDF includes a feed storage tank to allow accumulation of process blowdown (typically 2 to 3 days' capacity) in the event the ZLDF is off line due to maintenance or equipment failure.

TABLE 2.3-2

ESTIMATED COMPOSITION OF CRYSTALLIZER SOLIDS

CONSTITUENTS	WEIGHT %
Sodium	17.10
Potassium	0.95
Calcium	6.60
Magnesium	2.70
Manganese	0.00
Iron	0.00
Aluminum	0.00
Boron	0.06
Ammonia	0.00
Hydroxide	0.00
Bicarbonate	9.40
Carbonate	0.00
Chloride	6.60
Sulfate	44.80
Nitrate	3.80
Silica (as SiO_2)	1.40
Bound Water	7.00
Total	100.0%

2.3.7.4 Circulating Water

Makeup water for the circulating water system is supplied directly from softened, clarified raw water from the RWSC system and excess recovered distillate from the ZLDF. The circulating water chemical feed system will supply water conditioning chemicals to the circulating water system to minimize corrosion, scaling and biofouling.

A corrosion and dispersant polymer are fed into the circulating water system in an amount proportional to the circulating water blowdown flow. The chemical feed equipment includes chemical containers and metering pumps.

To inhibit biofouling, sodium hypochlorite (biocide) is fed into the circulating water system. The sodium hypochlorite feed equipment includes a chemical container and metering pumps.

2.3.7.5 Circulating Water System Blowdown

The circulating water is partially evaporated in the cooling tower to approximately 12 to 16 cycles of concentration for most constituents, depending on the actual water quality characteristics encountered during plant operations. The concentration of dissolved solids in the circulating water is maintained below given limits by withdrawing a portion of the circulating water (i.e., cooling tower blowdown) and replacing it with fresh makeup water from the RWSC or the raw water/firewater storage tank and with excess distillate from the ZLDF. The circulating water blowdown stream is sent as the main feed to the ZLDF for recovery of distillate water.

2.3.7.6 HRSG Makeup

Water for the HRSGs must meet stringent specifications for suspended and dissolved solids. To meet these specifications, demineralization is accomplished by passing the desalinated distillate from the ZLDF evaporator through an EDI system to remove most of the remaining dissolved solids, allowing the water to be used as feed to the boiler feed water makeup. A portable, mixed-bed polishing unit (resin regenerated offsite) is used as a guard to ensure consistent water quality. Storage of demineralized product water is provided in a demineralized water storage tank with a working capacity of 225,000 gallons. This provides sufficient capacity for 24 hours of peak load operation even in the event of an outage of the water treatment system. Filtered water from the raw water/firewater storage tank can also be used as backup water supply to the mixed-bed polisher in the event of an outage of the water treatment system.

Additional conditioning of the condensate and feedwater circulating in the steam cycle is provided by means of a chemical feed system. To minimize corrosion, an oxygen scavenger for dissolved oxygen control and an alkaline solution for pH control are fed into the condensate. To minimize scale formation, a solution of alkaline phosphate is fed into the feedwater of both the HP and IP drums of the HRSG. The chemical feed system includes oxygen scavenger chemical containers, alkaline solution chemical containers, phosphate solution chemical containers for the HP drum, and phosphate solution chemical containers for the IP drum. Each of the chemical containers is provided with two full-capacity metering pumps, except for the phosphate chemical feed system which in addition to two full-capacity metering pumps, has a common spare.

2.3.7.7 HRSG Blowdown

Water circulating in the plant steam cycle accumulates dissolved solids that must be maintained below given limits to prevent deposition of solid particles on the steam turbine blading of the STG. The concentration of dissolved solids is maintained below such limits by withdrawing a portion of the water from the HRSG steam drums (i.e., HRSG blowdown) and replacing it with product water from the demineralization process previously described. The HRSG blowdown is routed to the cooling tower basin.

2.3.7.8 Closed-Loop Cooling Water

Closed-loop cooling water (CLCW) is used to cool equipment such as the CTG and STG lubrication oil coolers, the CTG and STG generator coolers, air compressor aftercoolers and steam cycle sample coolers. The cooling water circulates in a closed-loop system, with cooling of the CLCW provided by a heat exchanger using the circulating water system. Service water makeup to the CLCW system may be filtered, and a corrosion inhibitor such as sodium nitrite may be fed into the closed-loop cooling water system. Propylene glycol may be added to the CLCW to prevent freezing. A suitable antimicrobial may be added to control biological growth in the system.

2.3.7.9 Potable Water

Potable water will be supplied from the existing adjacent City of Avenal water treatment facility. Potable water will be used for toilets, showers, emergency eyewash and shower stations, while bottled water will be used for drinking.

2.3.7.10 Chemical Containment

The Project design includes secondary containment (e.g., curbing, slope) at chemical storage and feed areas to contain accidental spillage, maintenance operations and area washdowns. Sumps will be provided at the lowest point in the containment areas to facilitate removal using a portable pump. Liquids collected in the sumps that have characteristics of hazardous waste will be removed from the Site for treatment or disposal at an appropriately licensed facility.

2.3.7.11 Plant Drainage

There are three separate plant drainage systems - general plant drainage, sanitary sewage, and storm water.

General plant drainage includes storm water from the power block areas and process blowdown from all plant equipment and general plant drains. Storm water runoff from possible oil and chemical storage areas will be contained. Storm water contained in these areas will be routed through an oil/water separator. All of the collected water in general plant drainage including cooling tower blowdown, boiler blowdown, EDI blowdown, treated water from the oil/water separator and miscellaneous nonoily wastewater, generated in the operation of the plant are the feed streams to the ZLDF, which recycles purified distillate back to the power production cycle.

With the ZLDF to recycle process blowdown, there will be no wastewater discharge from plant. The only effluent discharges from the Project will be the sanitary sewer and storm water. The sanitary sewer system will be connected to an onsite septic tank and leach field. Clean storm water runoff will be collected onsite and drained via plant drainage system to a retention basin, where water will be disposed of either through evaporation or percolation.

2.3.8 WASTE HANDLING AND CONTROL

This section describes the management processes leading to proper collection, treatment and disposal of wastes. Further information on waste handling and control is provided in Section 6.14 - Waste Management. Wastes generated in conjunction with operation of the Project will include sanitation waste, nonhazardous waste and hazardous waste. As described in Section 2.3.7, the Project is designed with a ZLDF that will purify and recycle process blowdown so that water use is minimized and there is no process wastewater discharge.

2.3.8.1 Sanitation Waste

An onsite septic tank and leach field system will be provided for sink drains, toilets and other sanitary facilities. The sanitary system is based on gravity flow and will include lift stations if required. Permits for the system will be secured from Kings County.

2.3.8.2 Nonhazardous Waste

Operation and maintenance of the Project will produce solid, nonhazardous waste that is typical of power generation facilities. This waste includes scrap metal and plastic, insulation material, glass, empty containers, wood pallets, dewatered sludge from the raw water softener clarifiers, dewatered salt cake from the ZLDF and other miscellaneous solid wastes. Supporting administrative activities and Site personnel also will generate paper, cardboard, food waste and other discards. Wastes suitable for recycling will be recycled. Nonhazardous wastes that are not recycled will be disposed of through the local waste disposal company. Solid nonhazardous waste will be managed in accordance with applicable regulatory requirements to minimize health and safety impacts.

2.3.8.3 Hazardous and Universal Wastes

Operation and maintenance of the Project will generate various wastes that will meet the California Code of Regulations (CCR) Title 22 criteria for hazardous or universal wastes. Most of these wastes are produced in small amounts. Examples include waste oil, used oil filters, certain chemical wash solutions, spent solvents, spent paint materials, waste sand blast, spent batteries and spent fluorescent light tubes. Appropriate maintenance staff and other personnel will be trained to recognize and handle hazardous and universal wastes generated at the Site. Hazardous and universal wastes will be managed and disposed of or treated in accordance with relevant federal and state regulations at appropriately licensed facilities.

2.3.9 AIR EMISSIONS CONTROL AND MONITORING

The SJVUAPCD administers most state and federal air quality LORS relevant to the Project.(2) Air emissions from combustion of natural gas in the CTGs and HRSGs will be controlled using state-of-the-art systems. Emissions that are controlled include NO_x, CO, VOCs, PM_{10} and SO_2.

(3) EPA retains the authority to administer the federal Prevention of Significant Deterioration program in the San Joaquin Valley.

CEMSs will be installed to monitor stack emissions. All emissions values stated in the following subsections are based on parts per million by volume, dry basis (ppm_{vd}) corrected to 15 percent oxygen (O_2). A complete analysis and discussion of the air quality impacts of the Project is provided in Section 6.2 - Air Quality.

2.3.9.1 NO_x Emissions Control

The DLN combustors in the CTGs, followed by SCR in the HRSGs, will control stack emissions of NO_x to a maximum 2.5 ppm_{vd} at 15 percent O_2 (1-hour average, excluding start-ups). The DLN combustors control NO_x emissions to approximately 9 ppm_{vd} (at 15 percent O_2) at the CTG exhausts by premixing fuel and air immediately prior to combustion. Pre-mixing inhibits NO_x formation by minimizing the flame temperature and the concentration of oxygen at the flame front.

The SCR system includes a catalyst chamber located within each HRSG, catalyst bed, ammonia storage system and ammonia injection system. The catalyst chamber contains the catalyst bed and is located in a temperature zone of the HRSG where the catalyst is most effective over the range of loads at which the plant will operate. The ammonia injection grid is located upstream of the catalyst chamber. An aqueous ammonia solution (approximately 19 percent ammonia by weight) is vaporized and injected into the hot exhaust gas path of the HRSG at a point upstream of the SCR to assure proper distribution over the catalyst. The ammonia vapor and the NO_x chemically combine in the presence of the SCR catalyst to form nitrogen gas and water vapor. It is expected that the two 27,000-gallon aqueous ammonia storage tanks will have a 30-day storage capacity at the plant baseload operation and ambient temperature of 63°F. Excess ammonia beyond what is needed to react with the NO_x in the exhaust gas stream is emitted from the stack. This "ammonia slip" will be limited to 10 ppm_{vd}.

2.3.9.2 CO and VOC Emissions Control

An oxidation catalyst will be provided in each HRSG to limit CO emissions to 6 ppm_{vd} at 15 percent O_2. This catalytic system will promote the oxidation of CO to carbon dioxide. VOC emissions from the DLN turbine are expected to be below 2 ppm without additional control. While the oxidation catalyst may reduce VOC emissions, no additional reduction from the catalyst is assumed at these extremely low emission levels.

2.3.9.3 PM$_{10}$ and SO$_2$ Emissions Control

Fine particulate matter with aerodynamic diameter less than or equal to 10 micrometers (PM_{10}) emissions consist primarily of particles formed during combustion. The PM_{10} emissions are controlled by the use of natural gas fuel.

The SO_2 emissions also are controlled by the use of natural gas fuel, which contains only trace quantities of sulfur in the mercaptan added as an odorizer for safety.

2.3.9.4 Emissions Monitoring

The CEMS samples, analyzes, and records NO_x, CO and O_2 concentrations in the stack exhaust. The CEMS also generates a log of emissions data for compliance documentation and activates an alarm in the plant control room when stack emissions exceed specified limits. The CEMS systems will be required to meet specifications of the federal acid rain (Title IV) program, and to undergo periodic calibration, audits and testing to verify accuracy.

2.3.10 PROJECT NOISE CONTROL FEATURES

Project noise control features will not only contribute to a safe working environment within the plant, but also will ensure compliance with local noise standards in the surrounding community. Specific noise control equipment that will be incorporated as part of facilities design includes:

- CTG inlet air silencer
- Gas turbine enclosure
- Steam turbine enclosure
- Instrument/service air compressor enclosure
- Control valves specified as low-noise units, as needed.

More detailed information and a noise analysis are provided in Section 6.12 - Noise Control.

2.3.11 FACILITY SAFETY AND EMERGENCY SYSTEMS

2.3.11.1 Safety

The Project will be designed, operated and maintained to comply with applicable Occupational Safety and Health Administration (OSHA) regulations and standards for worker health and safety, and other applicable LORS for environmental and public health and safety. The Project will have fire protection and suppression systems designed to meet current National Fire

Protection Association (NFPA) standards and specifications. Ancillary facilities and equipment necessary for safe and efficient operation will be provided. Facility operators will be trained to perform their duties and conduct themselves in a manner designed to prevent unsafe conditions. A system for intra-plant communication will be provided. Duke Avenal will conduct initial safety training and periodic refresher safety training, in accordance with OSHA regulations. Further discussion of safety systems is provided in Section 6.17 - Worker Safety.

2.3.11.2 Seismic Safety

Active surface faults are not known to occur on or adjacent to the Site, but strong ground shaking is possible from a ramp thrust fault that occurs deep below the surface throughout the Project vicinity. Geotechnical and seismic conditions will be evaluated as part of the design of the Project, and the Project will be constructed to comply with applicable seismic parameters and building codes. The California Building Code requires that structures be designed with adequate strength to withstand lateral displacements that would be induced by the earthquake ground motion that would have a 10 percent probability of being exceeded in 50 years. Further analysis of geotechnical and seismic conditions is contained in Section 6.3 - Geologic Hazards and Resources.

2.3.11.3 Emergency Planning and Response

Duke Avenal will maintain an emergency response plan to maximize the potential for prompt and appropriate response to reasonably foreseeable emergency situations. The emergency response plan will be submitted to local emergency response agencies. It will identify designated emergency coordinators, contacts and response equipment, and will address activities to be undertaken in the event of explosion, fire, hazardous material release, earthquake and other potential emergencies. Duke Avenal will provide formal training for all employees at the facility to assure readiness of emergency response procedures. Site facilities will include audible alarm code systems, internal and external telephone communication systems, and other systems necessary to provide for comprehensive emergency response.

2.3.11.4 Hazardous Materials Management

Various hazardous reagents and materials will be stored and used in conjunction with operation and maintenance of the Project. Hazardous materials that will be routinely stored in bulk and used for the Project include aqueous ammonia, petroleum products, flammable and compressed gases, acids and caustics, water treatment and cleaning chemicals, paint and solvents.

Storage, handling and use of hazardous materials will be in accordance with applicable LORS. Bulk tanks will be provided with secondary containment to hold leaks or spills. Safety showers and eyewashes will be provided in appropriate chemical storage and use areas. Personnel who may handle hazardous materials will be trained to perform their duties safely and to respond to emergency situations that may occur in the event of an accidental spill or release.

Duke Avenal will prepare the following: a Hazardous Materials Business Plan/Contingency Plan in accordance with CCR Titles 19 and 22; Spill Prevention, Control and Countermeasure Plan (SPCC) in accordance with Code of Federal Regulations (CFR) Title 40; SWPPP in accordance with RWQCB requirements. Each of these management plans includes detailed measures designed to prevent and/or respond to discharges, spills, leaks or other incidents involving hazardous materials. Additional descriptions of handling hazardous materials can be found in Section 6.15 - Hazardous Materials Handling.

2.3.11.5 Fire Protection

Fire protection systems are provided to limit personal injury, property loss and plant downtime resulting from a fire. The systems include a fire protection water system, carbon dioxide (CO_2) fire suppression systems for the CTGs, and portable fire extinguishers. The fire protection systems will be designed and installed in accordance with NFPA standards and recommendations. The fire protection water will be supplied from a dedicated 240,000-gallon portion of the raw water/firewater storage tank located onsite. Two 100 percent fire pumps with a capacity of 2,000 gpm will deliver water to the fire protection water piping network. One of the fire pumps will be driven by an electric motor, and the second pump will be driven by a diesel engine. A third pump, a small capacity jockey pump that will be driven by an electric motor, will maintain pressure in the piping network.

If the jockey pump is unable to maintain a set operating pressure in the piping network, the electric motor-driven fire pump will start automatically. If the electric motor-driven fire pump is unable to maintain a set operating pressure, the diesel engine-driven fire pump will start automatically.

The piping network is configured in a loop so that a piping failure can be isolated with shutoff valves without interrupting the supply of water to a majority of the loop. Fire suppression equipment supplied by the piping network includes fire hydrants and sprinkler systems. Fire hydrants are located at intervals throughout the Site. Sprinkler systems are provided in the administration and control building and the warehouse.

The CO_2 fire suppression system provided for each CTG will include a CO_2 storage tank, CO_2 piping and nozzles, fire detection sensors and a control system. The control system will automatically shut down the CTG, turn off ventilation, close ventilation openings, release CO_2 upon detection and confirm the existence of a fire. The CO_2 fire suppression systems will cover the turbine enclosure and accessory equipment enclosure of each CTG.

Portable fire extinguishers of appropriate sizes and types will be located throughout the Site.

2.3.12 FACILITY AUXILIARY SYSTEMS

The following plant auxiliary systems will support, protect and control Project facilities.

2.3.12.1 Lighting System

The lighting system provides operations and maintenance personnel with illumination in both normal and emergency conditions. The system consists primarily of alternating current (AC) lighting, and includes direct current (DC) lighting for activities or emergency egress required during an outage of the AC electrical system. The lighting system also provides AC convenience outlets for portable lamps and tools.

2.3.12.2 Grounding System

The power plant electrical systems and equipment are susceptible to ground faults, switching surges and lightning occurrences that can impose hazardous voltage and current on plant equipment and structures. To protect against personal injury and equipment damage, the grounding system provides an adequate path to ground for dissipation of hazardous voltage and current.

The grounding system is provided with adequate capacity to dissipate hazardous voltage and current under the most severe conditions. Bare conductor is installed below grade in a grid pattern, and each junction of the grid is bonded by welding or mechanical clamps. The grid spacing is designed to maintain safe voltage gradients. Ground resistivity readings are used to determine the necessary grid spacing and numbers of ground rods. Steel structures and nonenergized parts of plant electrical equipment are connected to the grounding grid.

2.3.12.3 Distributed Control System

The distributed control system (DCS) provides control, monitoring, alarm and data storage functions for power plant systems.

The following functions will be provided:

- Control of the CTGs, STG, HRSGs and balance-of-plant systems in a coordinated manner.
- Monitoring of operating parameters from plant systems and equipment, and visual display of the associated operating data to control operators and technicians.
- Detection of abnormal operating parameters and parameter trends, and provision of visual and audible alarms to apprise control operators of such conditions.
- Storage and retrieval of historical operating data.

The DCS is a microprocessor-based system. Redundant capability is provided for critical DCS components such that no single component failure will cause a plant outage. The DCS consists of the following major components:

- CRT-based control operator interface (redundant).
- CRT-based control technician workstation.
- Multi-function processors (redundant).
- Input/output processors (redundant for critical control parameters).
- Field sensors and distributed processors (redundant for critical control parameters).
- Historical data archive.
- Printers, data highways, data links, control cabling and cable trays.

The DCS is linked to the control systems furnished by the CTG and STG suppliers. These data links provide CTG and STG control, monitoring, alarm and data storage functions via the CRT-based control operator interface and control technician work station of the DCS.

2.3.12.4 Cathodic Protection System

The cathodic protection system will be used as required to protect against electrochemical corrosion of underground metal piping and structures. Separate cathodic protection systems will be installed to protect the newly installed natural gas pipeline that will provide fuel to the new generating facility. The design of this system will require a separate cathodic survey after the pipeline is installed.

2.3.12.5 Freeze Protection Systems

Due to the infrequency and short duration of below-freezing ambient temperatures at the Project Site, freeze protection systems will be provided only in susceptible outdoor areas.

2.3.12.6 Service/Instrument Air System

The service air system supplies compressed air to hose connections located at intervals throughout the power plant. Compressors deliver compressed air at a regulated pressure to the service air-piping network. Air from the service air system is dried, filtered and pressure-regulated prior to delivery to the instrument air-piping network. The instrument air system provides dry, filtered air to pneumatic operators and devices throughout the power plant.

2.3.13 MAJOR ELECTRICAL SYSTEMS AND EQUIPMENT

This section describes the major electrical systems and equipment for the Project. Almost all of the power produced by the plant will be delivered via the PG&E electric transmission system. A small amount, however, will be used for onsite plant auxiliaries such as cooling tower, pumps, control systems, lighting, general facility loads that include heating, ventilation and air conditioning (HVAC), and for offsite plant auxiliaries such as groundwater pumps. Some power also will be converted to DC for the plant control and emergency backup systems. An overall one-line diagram of the major electrical systems is presented in Figure 2.3-6.

2.3.13.1 Step-Up Transformers and Plant Switchyard

Power will be generated at 18 kV by the two CTGs and STG, then stepped up to 230 kV for delivery to the power plant interconnection with PG&E. Each of the plant's three generators will be connected by an 18-kV bus to a dedicated 18 - 230 kV oil-filled, step-up transformer.

Each step-up transformer will rest on a concrete pad/pit designed to contain the transformer oil in the event of a leak or spill.

The high voltage side of each step-up transformer will connect to a 230-kV circuit breaker, which will then connect to a 230-kV switchyard. This switchyard will include two generation positions and two transmission line positions. The existing PG&E Gates-ARCO 230-kV transmission line will be looped into the plant switchyard. Additional information on the transmission interconnection with the PG&E transmission system is provided in Section 2.4.

2.3.13.2 Electrical System for Plant Auxiliaries

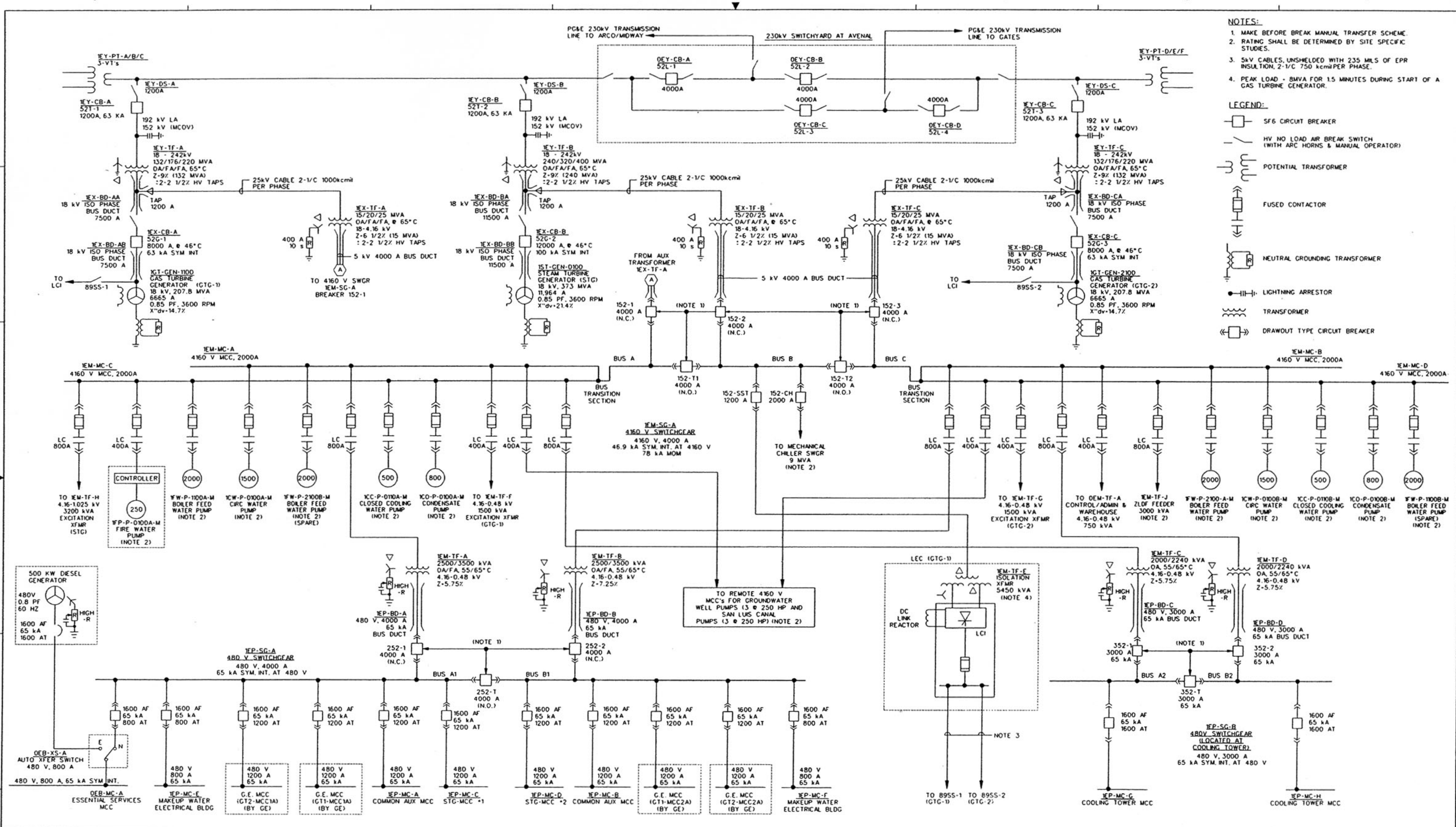
Power for plant auxiliaries will be supplied at 4160 volts (V) from two 18 kV - 4160-V oil-filled, step-down, auxiliary transformers connected to the two CTGs between the generator breakers and the CTG main step-up transformers. The low-voltage side of the auxiliary transformers is connected to 4160-V switchgear. This configuration allows the power for plant auxiliaries to be supplied from the plant switchyard, regardless of whether the CTGs are on-line or off-line. The auxiliary transformers will rest on concrete pads designed to contain the transformer oil in the event of a leak or spill.

The 4160-V switchgear distributes power to the plant's 4160-V motors, to the CTG starting system and to 4160 - 480-V oil-filled transformers. The low voltage side of the 4160 - 480-V transformers is connected to 480-V switchgear. The 480-V switchgear distributes power to the plant's large 480-V loads and to 480-V motor control centers (MCCs). The MCCs distribute power to the plant's intermediate 480-V loads and to power panels serving small loads of 480-V and lower.

The MCCs also distribute power to 480 - 277-V dry-type isolation transformers serving 277-V single-phase loads and to 480 - 208/120 dry-type transformers serving 208-V and 120-V loads.

2.3.13.3 DC Power Supply System

The DC power supply system will consist of a bank of 125-V DC batteries, 125-V DC battery chargers, metering, ground detectors and distribution panels. In addition, a similar DC power supply system will be provided as part of the auxiliary power system for each CTG.



REV.	DATE	REVISION DESCRIPTION	DRWD / CHK.	LAYO / MECH	CIVIL / ELEC	COGM / PROJ
A		PRELIMINARY	JS / AP	FW / N/A	N/A / RB	
B		PRELIMINARY	FP / AP	FW / N/A	N/A / RB	

DUKE/FLUOR DANIEL

DRAWN BY J. SKORUPSKA
CHECKED BY A. PATON
LAYOUT APPROVAL F. WINTERS
MECHANICAL APPROVAL N/A
CIVIL APPROVAL N/A
ELECTRICAL APPROVAL R. BONO
ENGINEERING MANAGER T. MUALLEN
PROJECT DIRECTOR

DUKE ENERGY AVENAL, LLC
AVENAL ENERGY PROJECT
AVENAL, CA

FIGURE 2.3-6
OVERALL ONE LINE DIAGRAM
CONCEPTUAL - BASE CASE

SCALE NONE
226879-0-SL-6- 1 B

MANUAL CHANGES MADE - YES ☐ NO ☐ CAD FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

$$$$date$time$$$$

Under normal operating conditions, the battery charger supplies DC power to the DC loads. The battery charger receives 480-V, three-phase AC power from the electrical system serving plant auxiliaries. The battery charger continuously charges the battery bank while supplying DC power to the DC loads. Under abnormal or emergency conditions when AC power is not available, the battery bank supplies DC power to the DC loads. The battery bank will be sized to power the DC loads for a sufficient amount of time to provide for safe and damage-free shutdown of the power plant. Recharging of the battery bank occurs whenever AC power becomes available.

The DC power supply system provides power for critical control circuits, for control of the 4160-V and 480-V switchgear and for DC emergency backup systems. Emergency backup systems include the essential service AC system and DC lube oil and seal oil pumps for the CTGs and STG.

2.3.13.4 Essential Service AC System

An essential service AC system (120 V, single-phase) provides power to essential instrumentation, critical equipment loads, safety systems and equipment protection systems that require uninterrupted AC power. The essential service AC system and DC power supply system will be designed to ensure that critical safety and equipment protection control circuits are always energized and able to function in the event of unit trip or loss of AC power.

The essential service AC system will consist of an inverter, a solid-state transfer switch, manual bypass switch, an alternate AC source transformer and AC panel boards.

The DC power supply system is the normal source of power to the essential service AC system. The DC power is converted by the inverter to AC power that flows through the solid-state transfer switch to the AC panel boards. The solid-state transfer switch continuously monitors both the inverter output and the alternate AC source. Upon loss of the inverter output and without interruption of power, the transfer switch automatically transfers essential service AC loads from the inverter output to the alternate AC source. The manual bypass switch enables isolation of the inverter and transfer switch for testing and maintenance without interruption of power to the essential service AC loads.

2.3.13.5 Emergency Diesel Engine Generator

An emergency diesel engine generator will provide power to the essential service AC system in the event of grid failure or loss of outside power to the plant. The diesel engine generator can be started via a remote control or local panel and has a diesel fuel oil day tank.

2.3.14 FUEL TYPES AND USES

This section describes the quantity of fuel required by the Project, as well as the source and quality of the fuel.

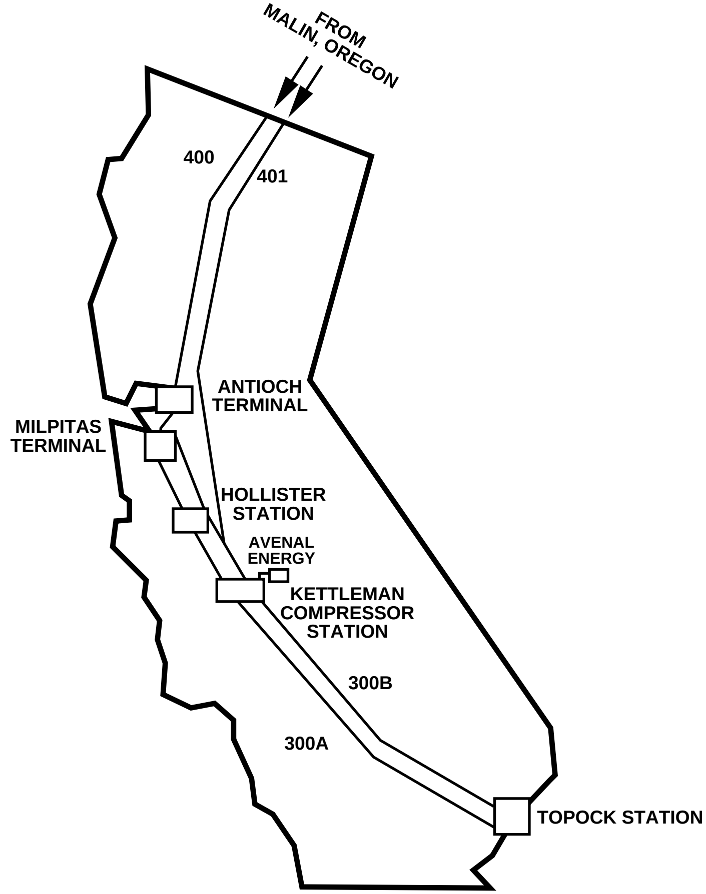
2.3.14.1 Source and Quality of Fuel Supply

Natural gas will be supplied to the Project through the PG&E pipeline network. PG&E receives more than 90 percent of the natural gas for redelivery in Northern California from the connection with El Paso Natural Gas near Topock, Arizona, and from the connection with PG&E/Northwest near Malin, Oregon.

As shown in Figure 2.3-7, parallel PG&E pipelines 300 A/B, both 34 inches in diameter, form the southern portion of the PG&E backbone system, which transports gas from the Topock compressor station in Southern California to the Milpitas terminal near San Jose. The Kettleman compressor station is one of three main line compressor stations providing pressure support on this southern system. The Topock to Milpitas pipeline has the capacity to transport 1,180 million cubic feed per day (MMcfd). Natural gas from the El Paso supplier typically has a higher heating value (HHV) in the range of 1,060 Btu/standard cubic feet (scf).

The northern system has two main trunk lines. Line 400 is a 36-inch-diameter pipeline between Malin, Oregon, and Antioch, California. Line 401 is a 42/36-inch-diameter pipeline between Malin, Oregon, and an interconnection on Lines 300A/B in the southern system near the Kettleman compressor station. The northern system has the capacity to import 1,800 MMcfd of Canadian natural gas into the PG&E system. Natural gas from the Canadian suppliers typically has an HHV in the range of 1,020 Btu/scf.

The Kettleman compressor station and PG&E pipelines 300 A/B are located approximately 2 miles southwest of the Site. Natural gas will be conveyed to the Site via a new 20-inch diameter underground pipeline interconnection from existing PG&E Lines 300 A/B at a point in the PG&E Kettleman compressor station. Figure 2.3-8 illustrates the proposed natural gas pipeline interconnection between the Project and the PG&E Kettleman compressor station.



NOT TO SCALE

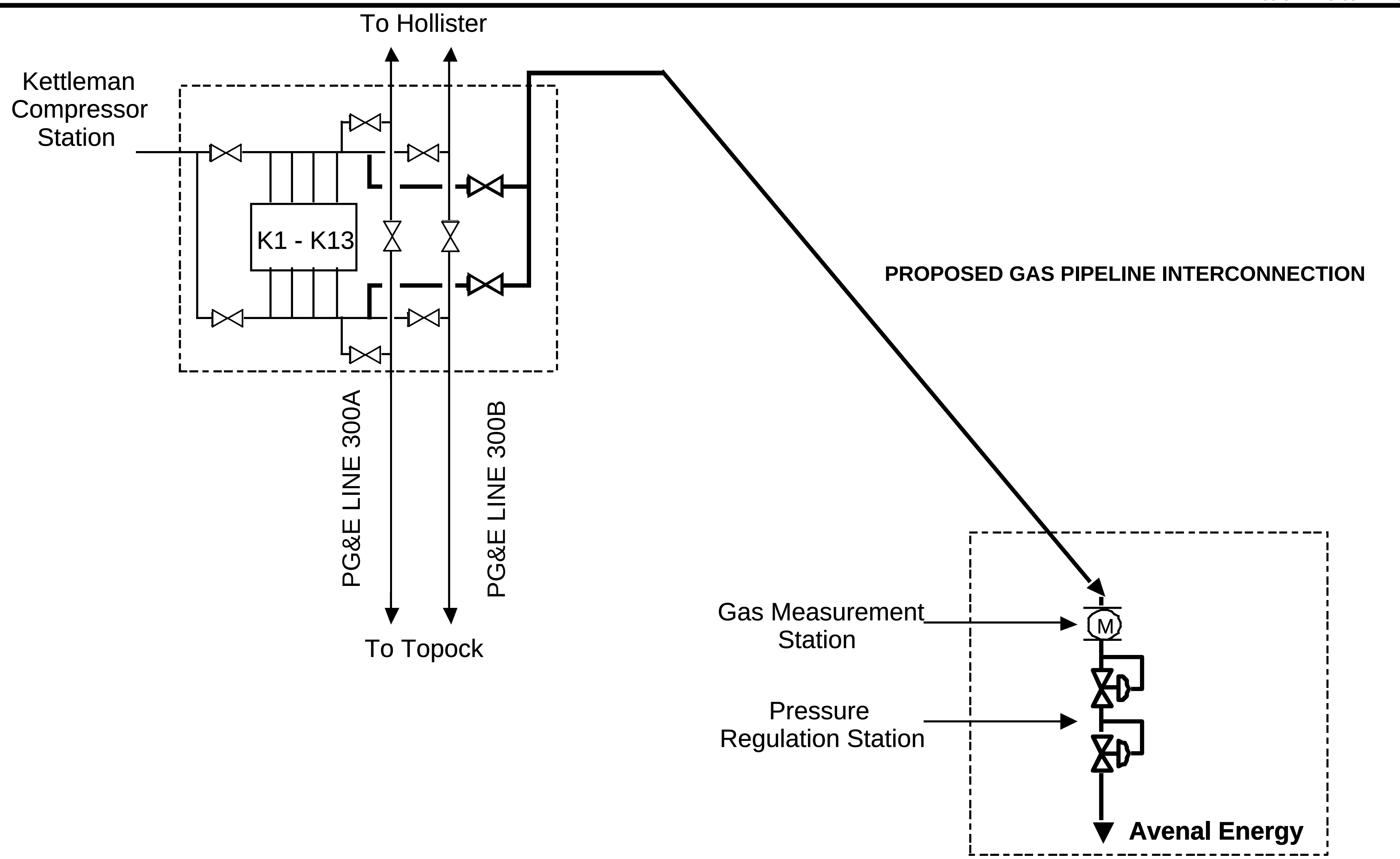
SOURCE: DUKE/FLUOR DANIEL, 2000.

PG&E GAS SYSTEM

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY | **FIGURE 2.3-7**

00-311AFC-65 REV.08/22/01



PROPOSED NATURAL GAS PIPELINE

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	**FIGURE 2.3-8**

Table 2.3-3 presents a typical fuel gas analysis.

The Project will not adversely impact the present ability of PG&E Lines 300 A/B to supply the local natural gas distribution system that is owned and operated by PG&E. The Kettleman Compressor Station can be operated via a block valve on the 300 A/B system and receive gas from both directions if necessary. Therefore, natural gas for the Project has increased reliability from redundant sources of supply through the PG&E pipeline system.

TABLE 2.3-3

TYPICAL PIPELINE QUALITY NATURAL GAS ANALYSIS

CONSTITUENT	PERCENT BY VOLUME
Methane	95.96
Ethane	1.95
Propane	0.24
n-Butane	0.07
i-Butane	0.00
n-Pentane	0.02
i-Pentane	0.00
Hexane+	0.01
Oxygen	0.00
Carbon dioxide	0.67
Nitrogen	1.08
TOTAL	**100.00**
Sulfur (grains per 100 scf)	0.25
Specific Gravity (air = 1.00)	0.59
Higher Heating Value (Btu per scf)	1,013

2.3.14.2 Fuel Consumptive Use and Interconnection

The CTGs and duct burners will be designed to burn natural gas. The natural gas consumption at base load operation is estimated at 85,797 million Btu per day (HHV). Based on 24 hours a day of peak load operation at annual average conditions, the natural gas requirement is approximately 105,465 million Btu per day (HHV).

The gas line interconnection will be located primarily within existing rights-of-way for Avenal Cutoff Road and Plymouth Avenue. An alternate route that may be used would follow a dirt agricultural road instead of the western portion of Plymouth Avenue. The interconnection route is shown in Figures 2.1-1 and 2.1-5. Over most of its alignment, the gas interconnection pipeline will be constructed and buried in a trench within Avenal Cutoff Road and Plymouth Avenue.

The natural gas will be delivered to the plant with sufficient pressure at the plant boundary so that additional fuel compression will not be required. A revenue-quality flow meter will be provided at the downstream end of the interconnection pipeline. The pipeline also will be provided with isolation valves and vent valves to allow the pipeline and associated equipment to be depressurized for maintenance or repair.

The natural gas will flow through a regulator station for pressure reduction, if needed, and on through the master plant metering station (which provides flow data and gas constituent information). Filtered and pressure-regulated natural gas will then be supplied to the CTGs and secondary gas regulator stations for each of the HRSG duct burner systems and the single auxiliary boiler. Safety pressure relief valves will be provided downstream of the pressure regulation stations. Each CTG fuel gas system will include a fuel gas preheater and flow-control equipment.

2.3.15 PLANT RELIABILITY AND AVAILABILITY

The Project will be designed for a minimum 30-year operating life. Availability projections are based on this projected operating life. To provide high plant reliability and availability, two measures will generally be taken. First, the redundancy of the auxiliary systems serving the individual turbine generators and the plant (see the major equipment list in Appendix 2-7) will provide standby capability on an auxiliary component failure. Second, planned outages for each of the CTGs would normally be scheduled during times when regional electric demand is low, when low-cost surplus capacity would be available.

The CTG inspections and overhauls will dictate the length and frequency of major scheduled outages. CTG inspections of the combustors and rotating sections will require a 1- to 2-week scheduled outage each year. Major CTG overhauls will be required approximately every 3 to 5 years. Scheduled outages for major overhauls will last from 3 to 12 weeks for each CTG, depending on the scope of work and availability of spare parts. Major hot-section overhauls will be required at approximately 25,000 equivalent fired hours, and major overhauls of the complete turbine and compressor will be required at about 50,000 hours. Equivalent-fired hours include actual operating hours plus a factor for number of starts. Experience with similar large-frame type CTGs indicates that the first major overhaul will be required during the third year of operation for the combined-cycle configurations.

Plant operations and maintenance staff during normal operation will perform preventive maintenance. Duke Avenal will utilize a maintenance program designed to minimize unplanned maintenance and forced outages. This program will incorporate preventive and predictive maintenance in a maintenance management system and will provide for rapid and effective response to unplanned maintenance events that require corrective maintenance action. The program will utilize plant personnel as well as outside contract services. The maintenance program will conform with California Independent Systems Operator requirements (as required by Executive Order D-23-01), including requirements for coordination. An outline of the maintenance program is shown in Table 2.3-4. Qualitative evaluations of program effectiveness and continuous improvement will be utilized to maintain optimum levels of reliability and availability.

TABLE 2.3-4

**MAINTENANCE PROGRAM OUTLINE
FOR AVENAL ENERGY**

- **1. Minor Maintenance (Planned and Unplanned)**
    - 1.1 Plant Personnel
        - 1.1.1 Preventive
            - 1.1.1.1 Planning
                - 1.1.1.1.1 Experience
                - 1.1.1.1.2 COS Operations and Maintenance (O&M) Procedures
                - 1.1.1.1.3 Manufacturer's Guidelines
                - 1.1.1.1.4 Regulations
            - 1.1.1.2 Maintenance Management System
                - 1.1.1.2.1 Minor Inspections
                - 1.1.1.2.2 Equipment Surveys
                - 1.1.1.2.3 Lubrication
                - 1.1.1.2.4 Component Replacement
        - 1.1.2 Emergency
            - 1.1.2.1 Minor Troubleshooting and Repair
    - 1.2 Contract Services
        - 1.2.1 Preventive
            - 1.2.1.1 Minor Inspections
            - 1.2.1.2 Component Replacement
        - 1.2.2 Emergency
            - 1.2.2.1 Minor Troubleshooting and Repair
- **2. Major Maintenance (Planned and Unplanned)**
    - 2.1 Contract Services
        - 2.1.1 Scheduled Overhauls
        - 2.1.2 Major Repair

2.3.15.1 Expected Plant Availability Factor

It is expected that the preventative maintenance program will result in high plant availability. Plant availability refers to the available generating capability during a given period of time and is assessed using the Equivalent Availability Factor (EAF). The EAF is a weighted average measure of plant availability, considering both full and partial outages. In determining the EAF, full and partial outages are weighted by duration and magnitude (i.e., fractional reduction in available generating capacity). Outages consist of planned overhauls, maintenance outages and forced outages; partial outages may be either scheduled or forced. The annual EAF is expected to be in the range of 92 to 96 percent. The combined-cycle unit is better suited for base load operation, but can operate efficiently at part loads.

2.3.15.2 Equipment Redundancy

Equipment redundancy provides means to avoid outages and reduce the magnitude of outages. For example, because the plant will include two air compressors of 100 percent capacity each, an outage of a single air compressor would not result in a plant outage. As another example, because the cooling tower will consist of multiple cells, an outage of one cell would result in a minor partial outage (i.e., minor reduction in available generating capacity) rather than a full outage.

Equipment redundancy also provides for operating flexibility and efficiency. For example, although the turn-down capability of individual CTGs is limited to about 50 percent, the plant will be able to turn down to approximately 25 percent load by shutting down one redundant CTG/HRSG train. Similarly, because of multiple CTG/HRSG trains, condensate pumps, boiler feed pumps, circulating water pumps and cooling tower cells, plant efficiency at 50 percent load will be similar to efficiency at 100 percent load by selectively shutting down redundant equipment. A summary of major equipment redundancy is presented in Appendix 2-7.

In general, the Project will be designed so that no single rotating machinery component failure in the balance-of-plant and no single-point failure in the plant control system will cause a combustion turbine HRSG "train" to go off-line. Likewise, no single switchyard circuit breaker or main step-up transformer failure will isolate the plant from the PG&E grid system. The multiple combustion turbine trains add a significant degree of redundancy to the plant.

Prime equipment for each train (i.e., combustion turbine, heat recovery steam generator and steam turbine) will not have redundant equipment. Each support system will include redundant equipment to be evaluated on a system-by-system basis during the engineering and procurement phase.

In addition to hardware redundancy in plant design and construction, there will be administrative and operational considerations that enhance plant reliability. Plant operations and maintenance activities will be carried out in accordance with documented procedures and by personnel trained in accordance with a documented training program. The training program will include classroom and hands-on training. Plant operator and maintenance personnel also will participate in the commissioning, startup and test activities during construction. Selected spare parts for plant equipment and machinery will be maintained onsite to minimize the duration of unplanned outages, further enhancing plant operating reliability.

2.3.15.3 Equipment Reliability

Duke Avenal will be operating in a competitive market where profitability will depend on the units operating reliably without requiring excessive maintenance time or expenditures. The first step in achieving high equipment reliability will be through a careful process of technical and commercial specification, qualification of suppliers, final selection of equipment, and a formal quality assurance and control program instituted throughout the design, fabrication, installation and startup process. After the new units begin commercial operations, continued reliability will be achieved through performance and condition monitoring and through a formal maintenance program designed to provide optimum long-term equipment reliability and unit availability. Inherent design-related and recurring equipment problems will be tracked and trended. Investigation and development of corrective action will be aggressively pursued, with manufacturer participation included in most cases.

Other measures Duke Avenal will take include:

- Monitor manufacturers' advisories and equipment upgrade offerings.
- Participate in user group organizations.
- Stay abreast of opportunities for capital improvements and upgrades.
- Attend manufacturer-sponsored seminars and technical conferences to keep current with industry experience with equipment similar to that of the Project.

The current reliability of the "F" class gas turbines manufactured by General Electric (GE) are among the highest of all gas turbines commercially available today. More than 100 of the GE 7FA combustion turbines are in operation and have collectively logged millions of hours of operation.

The development of combustion turbine technology is still dynamic. New features developed for the advanced design turbines are often incorporated or even retrofitted into current generation designs. Currently, gas turbine development is directed primarily at achieving increased efficiency, reduced emissions and improved reliability. Recent advancements include increasing compressor efficiency, improving the dry low NO_x combustor design, and increasing reliability by improving equipment condition monitoring with advanced gas turbine control systems.

Manufacturers have been generally successful in achieving these multiple objectives because they rely on incremental development and improvement rather than radical redesign. The "F" class combustion turbines have been commercially available for about 10 years and are becoming commercially mature. Many of the fundamental design features, materials and manufacturing techniques used in these machines are the same as those used in earlier generation models of 15 to 20 years ago. Improvements developed for the advanced design "F" class machines are being incorporated into the older design models, so that a "mature" design often includes many of the newest design, material and manufacturing features. The "F" class combustion turbines are proven designs that include improvements over previous generation machines in terms of reliability, efficiency and emissions.

Other major equipment, including HRSGs, steam turbine, condenser and cooling tower will be specified and procured from a select group of manufacturers with extensive and proven experience and capabilities. The required size of this equipment and the flows, pressures and temperatures under which they must operate are equivalent to power plants that have been in operation for 40 to 50 years. They represent design conditions that have been achievable for over 60 years.

Standard manufacturers' warranties and performance guarantees will be required as a condition of procurement. Reliability guarantees may also be available from some manufacturers. These guarantees are generally provided in the form of insurance or liquidated damages and should not be assumed, for the purposes of this section, to directly alter the performance of a specific piece of machinery. Rather, they should be considered indicative of how well the manufacturers expect their equipment actually will perform.

2.3.15.4 Fuel Availability

As stated in the Commission's 1995 Natural Gas Market Outlook, California has a total natural gas resource base of 1,056 trillion cubic feet (tcf) from surrounding basins in the Rocky Mountains, southwestern United States and Canada. This resource base is expected to satisfy current production levels for the next 60 years. Therefore, sufficient supplies of natural gas are projected to be available throughout the life of the Project. Further, new and expanded pipelines have increased the supply diversity into the region through new and expanded access routes to multiple supply basins. These activities have largely eliminated the risk of supply curtailment in the region and have allowed access to more competitively priced supplies.

2.3.15.5 Water Availability

As described in Section 2.3.7.1, water for the Project will be supplied by KCWA through the San Luis Canal. The surface water supply will be conveyed via an underground water supply pipeline extending from the City of Avenal turnout to the Site. The turnout will be provided by the City of Avenal. Existing agricultural wells will provide a backup supply. The backup water supply pipelines to existing wells also will be underground. The locations of the existing wells are shown in Figure 2.1-5. Characteristics of the wells are described in Section 6.5 - Water Resources.

At the power plant Site, a raw water/firewater storage tank with a capacity of 2-million gallons will hold 1.7-million gallons of water for plant operation. This quantity is sufficient to cover a 9-hour interruption of water supplied to the power plant. In addition, raw water/firewater storage will hold 240,000 gallons of water dedicated to the plant's fire protection water system.

2.3.15.6 Project Quality

This section summarizes the Project Quality Control Program that will be applied to the Project. The objective of the Project Quality Control Program will be to maximize confidence that systems and components will be designed, fabricated, stored, transported, installed and tested in accordance with the technical codes and standards appropriate for a power plant. Selective controls will be applied to various Project activities, such as checking and reviewing engineering design work. Appropriate quality control measures for manufacturing and construction include inspections, surveillance and testing.

For purposes of the Project Quality Control Program, Project activities are divided into the following stages:

- **Conceptual Engineering** - Typical activities include technical screening studies, preliminary evaluation of permitting requirements, developing plant cycle design criteria, estimating plant performance, defining site-specific characteristics and estimating capital costs to support economic studies.

- **Detailed Design -** Typical activities include preparation of specifications, drawings, lists and other technical data needed to describe, illustrate or define systems, structures or components of the plant. This phase of work will be accomplished by a turnkey engineering, procurement and construction (EPC) contractor through a formal competitive procurement process administered by Duke Avenal. Duke Avenal's engineering staff will review selected document packages for conformance with Project requirements.
- **Procurement Specification Preparation -** This work also will be performed by the EPC contractor. Typical work includes preparing and issuing formal, documented "packages" for suppliers of equipment or services. The supplier proposals are formally evaluated before a purchase order or contract is awarded.
- **Suppliers' Control and Surveillance** - Typical activities are those that the suppliers perform, as required by their purchase order(s) for equipment or contract(s) for services, to assure that the products or services conform to requirements of the purchase order or contract.
- **Supplier Data Review** - These activities, to be performed by the EPC contractor, include reviewing selected supplier drawings, data, instructions, procedures, plans and other documents to monitor conformance to the requirements of the EPC contractor's purchase order or contract. The EPC contractor's visits to supplier shops will be included, as appropriate, as well as Duke Avenal visits, when required.
- **Shipping and Receipt Inspections -** These activities, also to be performed by the EPC contractor, include inspection and review of products at the time of shipment and delivery to the construction site. Surveillance of this process may be performed by Duke Avenal engineering staff, if required.
- **Construction/Installation -** These activities include inspection and review of the EPC contractor's storage, installation, cleaning and initial testing of systems and components at the plant site. Where appropriate, Duke Avenal engineering staff will survey the EPC contractor's inspection systems.
- **System/Component/Plant Testing -** These activities are performed by the EPC contractor and witnessed by the owner's engineering staff. They require that the plant be commissioned, started up and tested in a documented and controlled manner to confirm that the performance of systems and components conforms to EPC contract requirements and guarantees.

2.3.15.7 Quality Control Records

The following quality control records, at a minimum, will be maintained for review and reference:

- Approved environmental and building permits
- Project procedures and instruction manual
- Design calculations and equipment specifications
- Project design basis
- Quality assurance audit reports
- Piping and instrument diagrams
- One-line and three-line diagrams
- Conformance to construction records drawings
- Procurement specifications (contract issue and change orders)
- Purchase orders and change orders
- Supplier's quality assurance and quality control records
- Correspondence and conference memoranda

For equipment purchase orders or services contracts, the EPC contractor will prepare a list of qualified suppliers and subcontractors. Before the EPC contractor awards a purchase order or contract, he will evaluate supplier/subcontractor capabilities, considering the supplier/ subcontractor track record, financial condition, personnel availability, production capability, past project performance and quality control program. The evaluation also may include a survey of the supplier's facilities.

During construction, commissioning and plant testing, field activities are accomplished by the EPC contractor, including receipt inspection, construction and installation, and system/ component/plant testing. The EPC contractor will be responsible for performing the work in accordance with the quality requirements specified by the EPC contract.

Subcontractor quality compliance will be monitored through EPC contractor inspections and audits, supplemented when necessary by the owner and/or owner's representatives.

2.3.15.8 Special Design Features

The Site terrain is relatively flat, and there are no adverse Site conditions that would require special engineering measures. The design utilizes proven, reliable technology. The primary special design feature is the ZLDF, which will reduce plant water consumption by approximately 10 percent. Systems that will be provided to ensure power plant reliability are described in Sections 2.3.15.2 - Equipment Redundancy, 2.3.15.3 - Equipment Reliability and 2.3.15.6 - Project Quality.

2.3.15.9 Power Plant Maturation Period

The advanced combined-cycle technology utilized in the Project design is a commercially tested and proven technology that is currently used in most modern power plant projects around the world. The expected maturation period corresponds to the time period from commissioning to commercial operation, approximately 6 months. The extensive Project Quality Control Program as well as functional testing, performance testing, reliability runs, and quality control records during commission and startup, will accelerate the Project maturation process.

2.3.16 EFFICIENCY

Heat and material balance case descriptions at design conditions for different modes of operation are summarized in Table 2.3-5.

TABLE 2.3-5

HEAT AND MATERIAL BALANCE CASE DESCRIPTIONS

CASE NUMBER	DESCRIPTION	AMBIENT TEMPERATURE	RELATIVE HUMIDITY	DUCT FIRE STATUS	CTGs INLET-AIR CHILLER STATUS
1	Hot Summer Day	97°F	23.7%	On	On
2	Hot Summer Day	97°F	23.7%	Off	On
3	Yearly Average	63°F	54.0%	On	On
4	Yearly Average	63°F	54.0%	Off	On
5	Cold Winter Day	36°F	85.0%	On	Off
6	Cold Winter Day	36°F	85.0%	Off	Off

Process flow diagrams with heat and material balances, including plant performance summaries, are provided in Appendix 2-6. The heat and material balances in Appendix 2-6 correspond to the six different operating conditions from Table 2.3-5 at three CTG loads (100 percent, 75 percent and 50 percent).

The power plant capacity factor will depend on the demand for electricity. However, based on estimates from weighted daily requirements and plant operations at expected load conditions, at average annual operating conditions of 63°F and 54 percent relative humidity unfired, using a capacity factor of 80 percent and 25 percent duct firing assuming 8,000 hours of plant availability, annual fuel consumption and annual net electrical output are 21,941,603 million Btu per year (HHV) and 3,125,857 megawatt-hours per year respectively.

A comprehensive discussion of alternative generating technologies available for the Project is provided in Chapter 5.0 - Alternatives Analysis.

2.3.17 PROJECT CIVIL/STRUCTURAL FEATURES

Project civil/structural features include site grading, drainage, equipment and facility foundations and structures. The following sections describe briefly the civil/structural features of the power plant. For more detailed descriptions, see Appendix 2-1, Civil Engineering Design Criteria and Appendix 2-2, Structural Engineering Design Criteria.

2.3.17.1 CTGs, HRSGs, STG and BOP Equipment

The CTGs, HRSGs, STG and condenser are located at grade elevation on reinforced concrete mat foundations. The balance of plant mechanical and electrical equipment will be supported at grade elevation on reinforced concrete foundations.

2.3.17.2 Site Drainage

The Site drainage system will comply with applicable LORS. General Site grading will establish a working surface for construction and plant operating areas, provide positive drainage from buildings and structures, and provide adequate soil coverage for underground utilities.

The Site drainage plan is shown in Figure 2.3-9, Conceptual Grading and Drainage Plan. Storm water runoff will be collected and directed to a retention basin where it will percolate and evaporate. The flow of storm water in undisturbed areas will generally follow the existing drainage pattern for pre-construction storm water runoff (Figure 2.3-10).

2.3.17.3 Storm Water Management

The climate in the Project area is dry, and surface runoff occurs at the Site only during and after substantial rainstorms. The Site terrain is relatively featureless, without areas of concentrated drainage. Site civil features will be designed to maintain approximate existing drainage conditions outside the developed area of the Site.

Duke Avenal will submit Notices of Intent to comply with the State Water Resources Control Board NPDES General Permits for management of storm water during both the construction and operations phases of the Project (Appendix 6.5-1). Construction-phase storm water management will occur in accordance with the NPDES General Permit for construction activities (Water Quality Order 98-08-DWQ). Operations-phase storm water management will occur in accordance with the NPDES General Permit for industrial activities (Water Quality Order 97-03-DWQ). Duke Avenal will develop and implement an SWPPP for construction and operations prior to the start of work. Storm water runoff will be managed in accordance with the SWPPP.

2.3.17.4 Site Grading

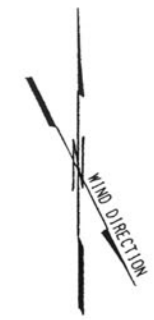
Site grading will comply with applicable LORS. Existing site topography will be cut and filled to create a plant grade with an approximate elevation of 340 feet above mean sea level. The Site is an active agricultural field that has been routinely tilled for decades. Earthwork for the power plant site will consist of removal and disposal of vegetation and debris, if present at the time of construction, excavation and compaction of earth to create the plant grade, and excavation for foundations and underground systems. Materials suitable for compaction will be stored in stockpiles at designated locations, using proper erosion prevention methods. Materials unsuitable for compaction, such as topsoil and large rocks, will be disposed of at an acceptable location.

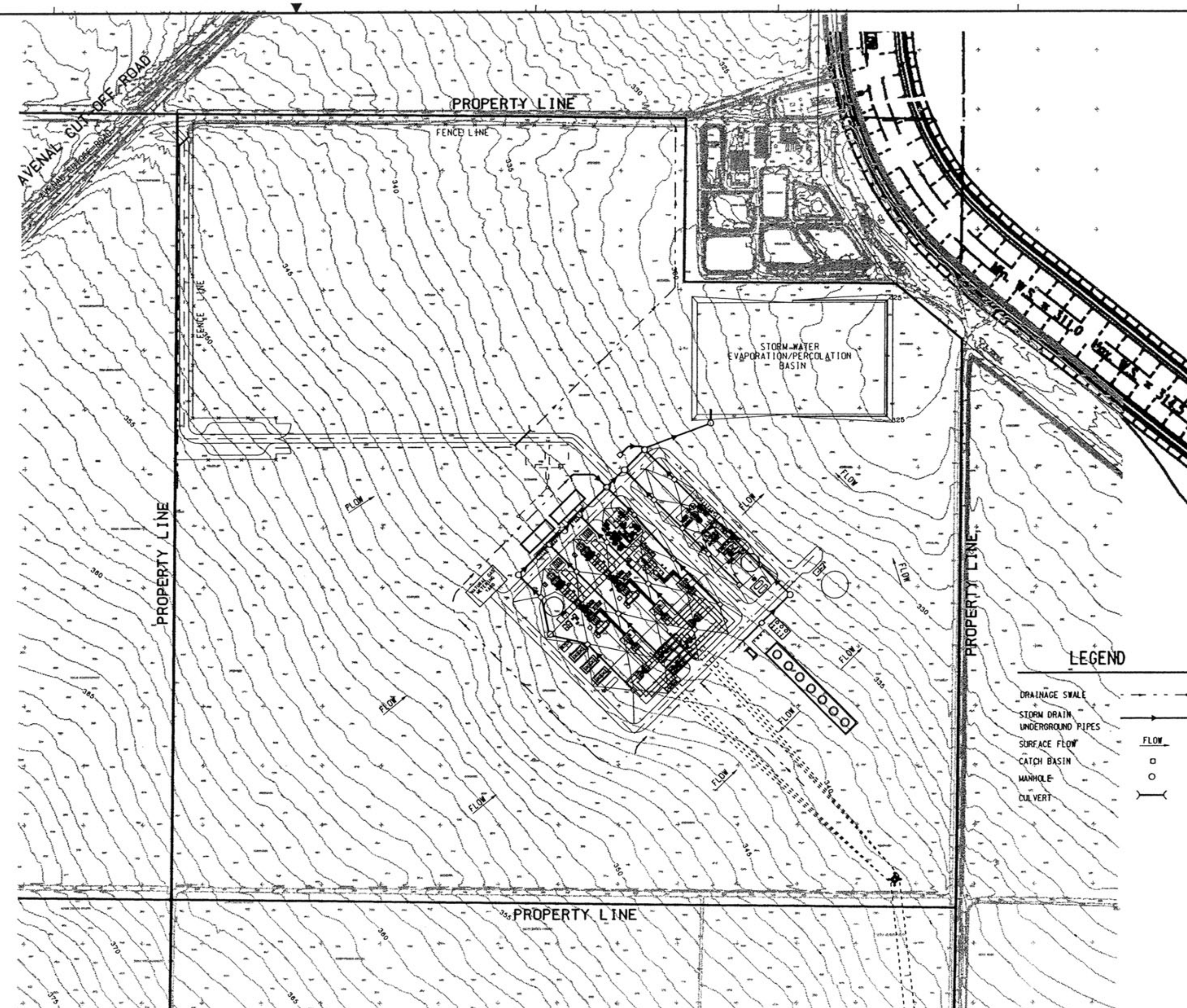
2.3.17.5 Erosion Control

Erosion control measures will be implemented during the construction phase of the Project and as needed after completion of the Project. Figure 2.3-11 - Conceptual Interim Grading and Erosion Control Plan shows methods that will be implemented. Figure 2.3-12 shows construction laydown and disturbance areas.

2.3.17.6 Landscaping

The Project has been designed and will be constructed to enhance the appearance of the City's industrial park area with minimal affect to views from surrounding areas. Nonreflective paint will be used for Site facilities. The landscaping plan includes perimeter screening vegetation and view corridors to achieve the City's visual goals for the Project. Landscaping will be included as part of the Project, consistent with the City of Avenal General Plan for industrial areas.





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REDUCED PRINT SCALE

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A	06-22-01	PRELIMINARY	JS					
B	08-20-01	UPDATED SITE PLAN	JS					
C	09-04-01	UPDATED DIVERSION DITCHES	JS					

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CHECKED BY: J. DAVIS	
INSPECTED BY LAYOUT	
INSPECTED BY SYSTEMS: T. SALTIKOV	
INSPECTED BY CSA	
INSPECTED BY ELECTRICAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR: T. MUALLEM	

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AVENAL ENERGY PROJECT
AVENAL, CALIFORNIA

FIGURE 2.3-9
CONCEPTUAL GRADING AND DRAINAGE PLAN

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
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CONTRACT PKG.   CADD FILE NO.   WRK. PKG.   DIST. CODE

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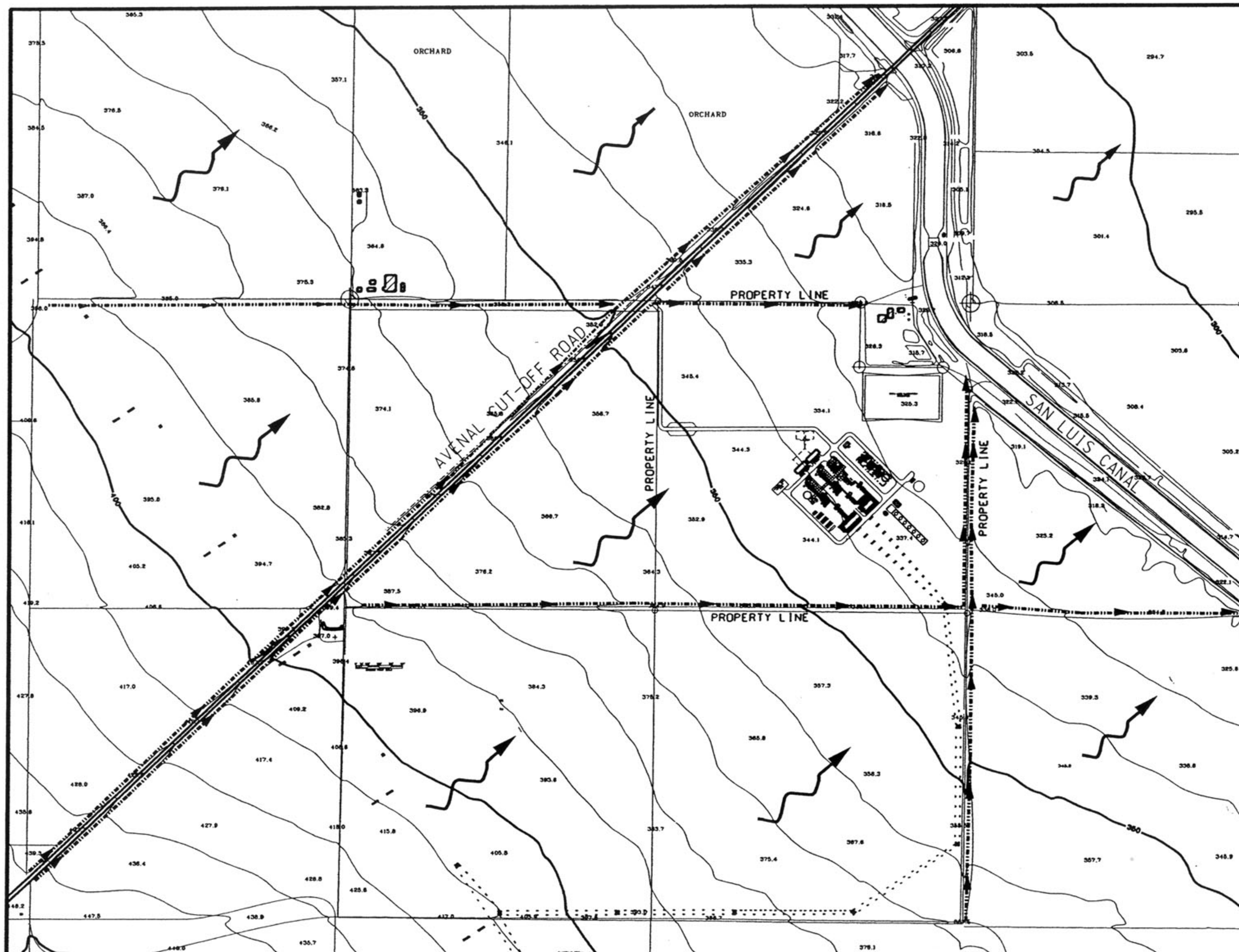

LEGEND

DITCH FLOW

SHEET FLOW

0' 250' 500' 1000' 1500' 2000'

REDUCED PRINT SCALE

REV.	DATE	REVISION DESCRIPTION	DRWN / CHK.
A	06-22-01	PRELIMINARY	JS
B	08-20-01	UPDATED SITE PLAN	BC

DWG. NO. | REFERENCE DRAWINGS

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INSPECTED BY LAYOUT		
INSPECTED BY SYSTEMS	T. SALTIKOV	
INSPECTED BY CSA		
INSPECTED BY ELECTRICAL		
ENGINEERING MANAGER		
PROJECT DIRECTOR	T. MUALLEM	

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FIGURE 2.3-10
PRE-CONSTRUCTION RUNOFF
AND DRAINAGE PLAN

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
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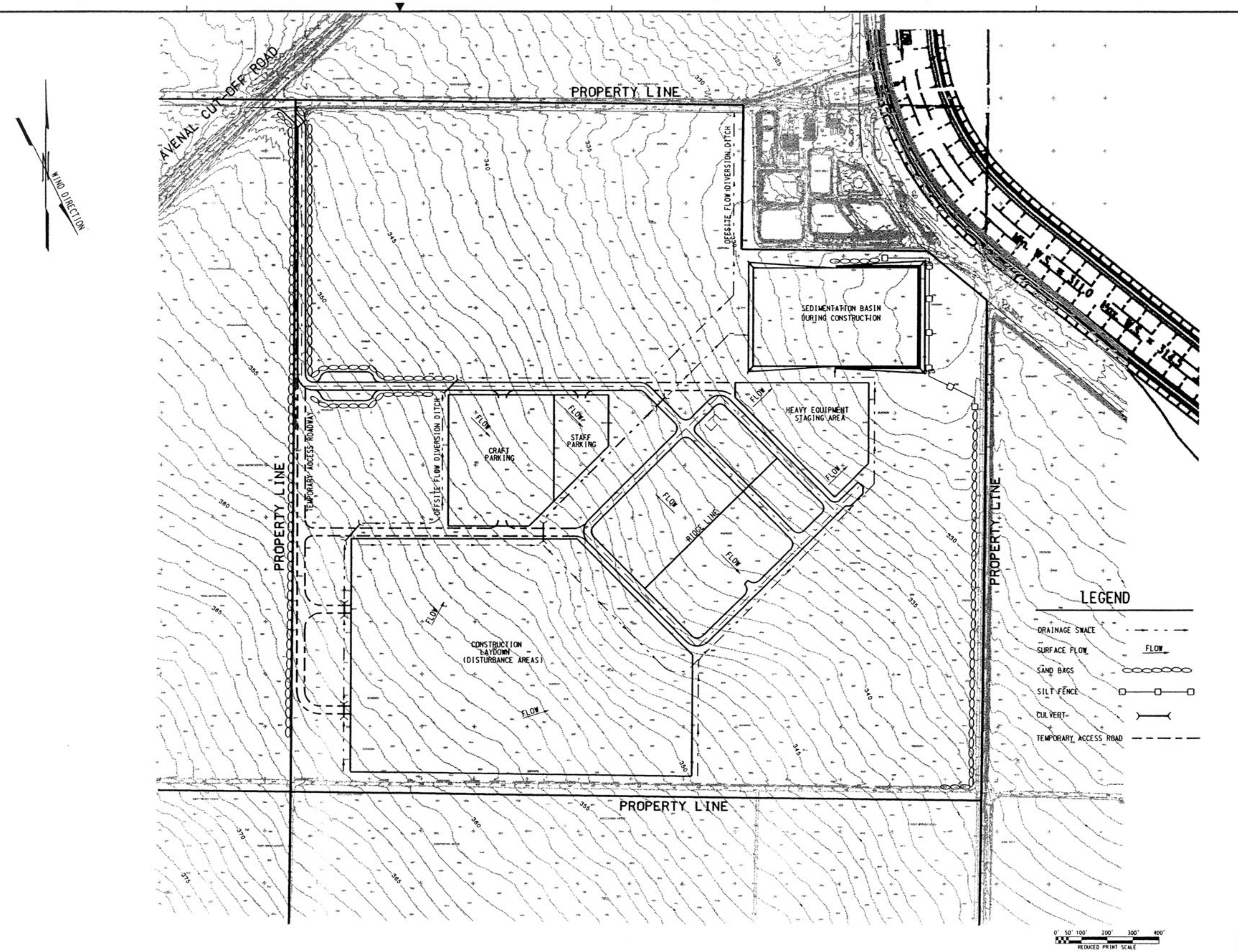

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B	08-20-01	UPDATED SITE PLAN	JS			
C	09-04-01	UPDATED CONSTRUCTION LAYDOWN, PARKING AND STAGING AREAS	JS			

DWG.NO. | REFERENCE DRAWINGS

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INSPECTED BY ELECTRICAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR T. MUALLEM	

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FIGURE 2.3-11
CONCEPTUAL INTERIM GRADING AND EROSION CONTROL PLAN

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
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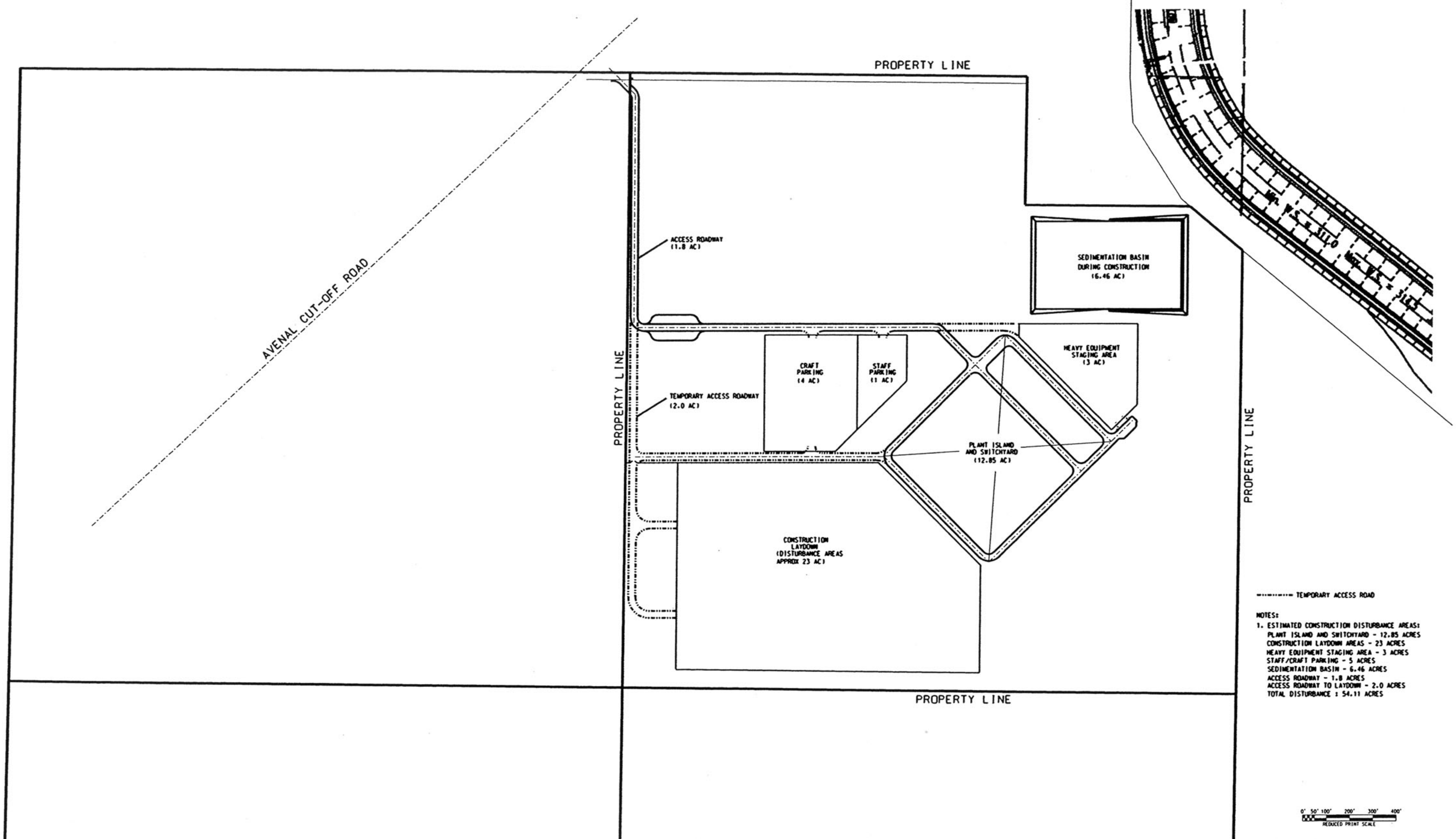

NOTES:

1. ESTIMATED CONSTRUCTION DISTURBANCE AREAS:
   PLANT ISLAND AND SWITCHYARD - 12.85 ACRES
   CONSTRUCTION LAYDOWN AREAS - 23 ACRES
   HEAVY EQUIPMENT STAGING AREA - 3 ACRES
   STAFF/CRAFT PARKING - 5 ACRES
   SEDIMENTATION BASIN - 6.46 ACRES
   ACCESS ROADWAY - 1.8 ACRES
   ACCESS ROADWAY TO LAYDOWN - 2.0 ACRES
   TOTAL DISTURBANCE : 54.11 ACRES

REV.	DATE	REVISION DESCRIPTION	DRWN CHK.	LAYO SYS	CSA ELEC	ENGM PROJ
A	07-18-01	PRELIMINARY	BC			

DWG.NO. | REFERENCE DRAWINGS

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CHECKED BY K. WEYANT	
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INSPECTED BY SYSTEMS	
INSPECTED BY CSA	
INSPECTED BY ELECTRICAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR T. MUALLEM	

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FIGURE 2.3-12
CONSTRUCTION OFFICES,
PARKING AND LAYDOWN AREAS

SCALE	PROJECT NUMBER	UNIT No	DOC TYPE	FUNC	SUBJECT CODE	SEQ No	REV.
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CADD FILE NO. | WRK. PKG. | DIST. CODE | CONTRACT PKG.

Plot User USERNAME | Plot Date & Time $$$$DATE$TIME$$$$

MANUAL CHANGES MADE - YES ☐ NO ☐ DWG. FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

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Aesthetic landscaping will be used on the Site and road frontage to enhance the property. The landscaping plan will be coordinated with the City of Avenal. The landscaping plan for the Project is described in detail in Section 6.13 - Visual Resources.

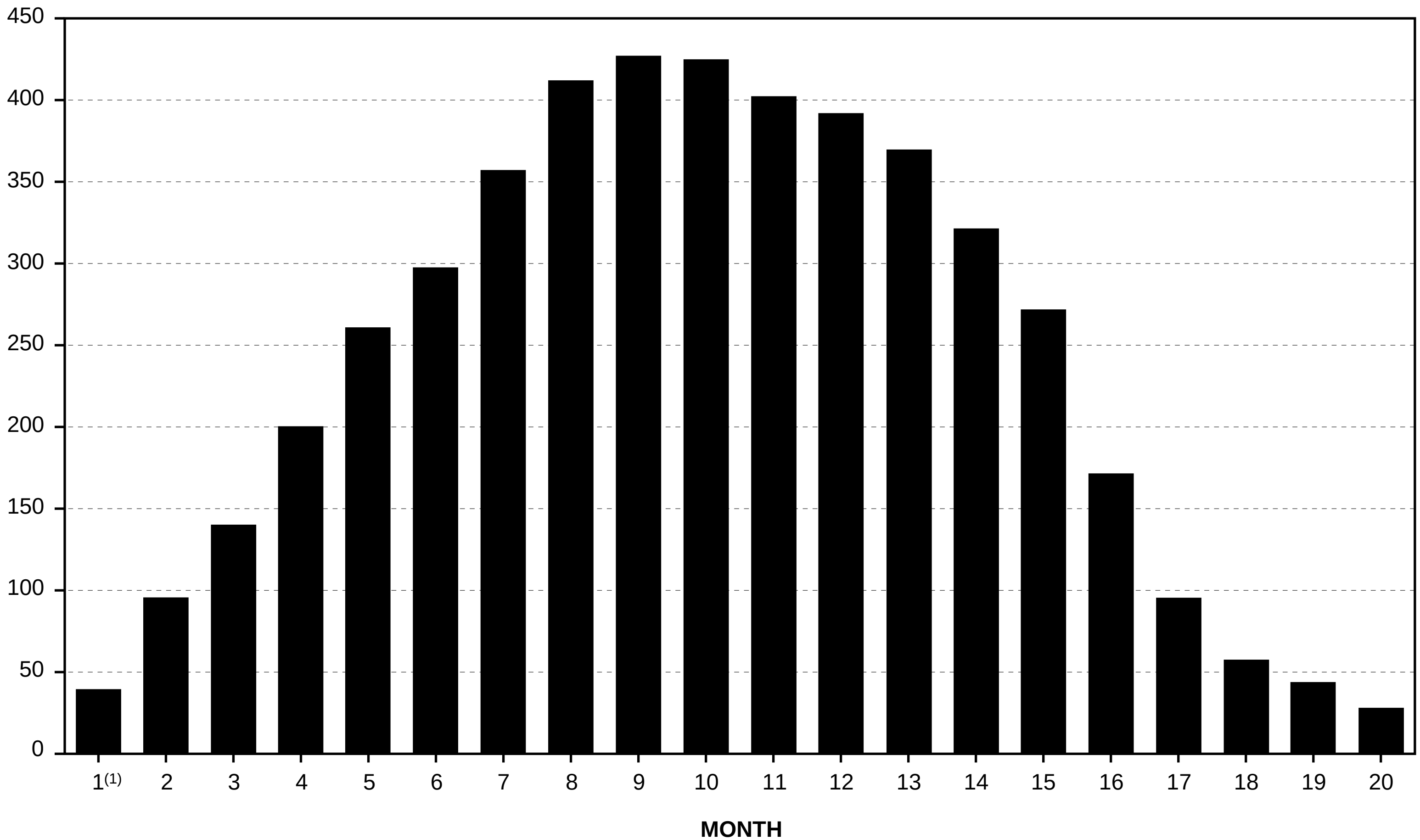
2.3.18 PROJECT CONSTRUCTION

Engineering, procurement and construction (EPC) of the Project will occur over an estimated approximately 25 to 26 months. The construction period is estimated at 20 months through the commercial operating date (COD). Figure 2.3-13 provides a projection of construction staff requirements over the 20-month construction period. Table 2.3-6 provides a breakdown of the construction staff requirements by craft.

Construction is expected to begin early in the first quarter of 2003, with commercial operation anticipated for the third quarter of 2004. These schedule estimates are based on successful and timely permitting and continued support for the Project.

The Site is located in an agricultural area and there are no nearby sensitive noise receptors. The schedule has been estimated on a single shift, between the hours of 7 a.m. and 5:30 p.m., Monday through Saturday. Additional hours and/or a second shift may be necessary to make up schedule deficiencies or to complete critical construction activities. During the start-up and testing phase of the Project, some activities may continue up to 24 hours per day, 7 days per week.

Construction access to the Site will be via Avenal Cutoff Road. Most construction workers traveling to the Site from the south and west (e.g., Avenal, Coalinga, Bakersfield) will reach Avenal Cutoff Road from Interstate 5. Most construction workers traveling to the Site from the north and east (e.g., Hanford, Visalia, Fresno) will reach Avenal Cutoff Road via State Highway 198. Traffic management plans will be implemented for construction workers, shift changes and hauling of oversize loads to the Site. Estimates of average and peak construction traffic during the onsite construction period, and traffic management for construction, are described in detail in Section 6.11 - Traffic and Transportation. The following subsections provide a description of construction activities.



LEGEND

TOTAL CONSTRUCTION PERSONNEL

SOURCE: DUKE/FLUOR DANIEL, 2001.

PRELIMINARY
CONSTRUCTION STAFFING PLAN

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	**FIGURE 2.3-13**

TABLE 2.3-6

AVENAL ENERGY PROJECT CONSTRUCTION STAFFING PLAN

JOB CATEGORY	MONTH																				TOTAL PERSON MONTHS
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
<u>CRAFT</u>																					
Millwrights				6	6	16	20	24	24	24	24	24	24	21	13	4	4				234
Pipefitters		9	9	15	38	40	65	70	75	75	75	75	70	60	55	25	5	4	3		768
Equipment Operators	5	8	11	15	23	24	25	27	30	36	27	27	22	22	15	7	2				326
Iron Workers		5	15	20	24	24	24	24	24	15	15	10	10	5	5						220
Carpenters		8	20	30	36	36	36	36	30	24	10	10	10	6	6						298
Electricians	4	10	10	15	22	32	42	60	70	70	75	75	75	60	50	30	10	10	6	6	732
Teamsters	4	4	4	4	7	7	7	12	12	17	17	17	16	16	11	10	6				171
Boilermakers					8	20	30	55	60	60	60	60	60	44	35	20	5				517
Surveyors	3	3	4	5	6	6	6	6	6	6	6	4	3	2	1	1	1	1	1	1	72
Laborers	5	20	30	40	40	40	40	40	40	40	40	30	20	15	15	13	10	5	5	5	493
Painters / Insulators														10	10	10	5	5			40
Brick Layers / Masons							8	8	4	4											24
Total Craft Manpower Plan	21	67	103	150	210	245	303	362	375	371	349	332	310	261	216	120	48	25	15	12	3895
Total Staff Manpower Plan	17	28	36	50	50	51	52	49	50	53	53	59	59	59	54	50	46	31	28	16	891
Total Construction Manpower Plan	38	95	139	200	260	296	355	411	425	424	402	391	369	320	270	170	94	56	43	28	4786

TABLE 2.3-63.AI REV.09/27/01

2.3.18.1 Power Generation Facility

Construction activities for the power generation facility and onsite ancillary features will occur throughout the 20-month construction period. Figure 2.3-12 shows the onsite construction areas, including laydown and parking. Onsite construction activities include clearing of agricultural vegetation (if present at the onset of construction), grading, hauling and layout of equipment, materials and supplies, facility construction and testing. The Site occurs in an area of relatively featureless topography. Site grading will occur as necessary to form level building pads and achieve a cut/fill balance. The cut and fill depths are estimated to be approximately 10 and 6 feet, respectively. The Site access road and the storm water sediment basin will be constructed as part of initial Site grading, so these facilities will be in place shortly after construction is initiated. As construction is completed, construction laydown and parking areas and other areas of the plant will be landscaped to achieve the Project's visual design goals.

2.3.18.2 Gas Pipeline Interconnection

Construction of the natural gas pipeline interconnection will take approximately 4 months. It will be scheduled to be finished and operational in time to provide test gas to the power generation facility. Construction will occur in accordance with a traffic management plan to minimize impacts to traffic traveling on Avenal Cutoff Road and Plymouth Avenue.

The pipeline will be designed, constructed, maintained, owned and operated by Duke Avenal in accordance with applicable LORS. For most of the pipeline route, the pipeline will be installed beneath the pavement surface of Avenal Cutoff Road and Plymouth Avenue (Figure 2.1-5). The construction will involve a variety of crews performing the following typical pipeline construction activities: hauling and stringing of the pipe along the route; welding, radiographic inspection and coating of the pipe welds; trenching; lowering of the pipe into the trench; backfill of the trench; hydrostatic testing of the pipeline; tie-in to the existing pipeline, purging the pipeline; and cleanup and restoration of construction areas. Streets will be restored to specifications of the Avenal Improvements Manual or other specifications required by the City Engineer. An access agreement with the City will be obtained for construction and operation of the pipeline within the existing approximately 80-foot wide Avenal Cutoff Road right-of-way and the approximately 60-foot wide Plymouth Avenue right-of-way.

2.3.18.3 Transmission System Interconnection

The Project will be connected to the existing PG&E system by constructing a short, double-circuit, 230-kV line from the existing PG&E 230-kV Gates-ARCO transmission line

(Figure 2.1-5). Approximately seven towers are expected to be required for the electrical line interconnection. Construction of the interconnection line will consist of footing installation, tower construction and pulling of conductor. Once the line is constructed, the Gates-ARCO line will be cut and connected to the new double-circuit transmission line. This double-circuit line will be connected to a new switchyard at the Site, forming two separate lines: the Avenal-Gates and the Avenal-ARCO 230-kV lines. These two new lines will be operated by PG&E. The new transmission line interconnection will be placed in an approximately 120-foot right-of-way.

Construction of the new 230-kV transmission line interconnection will take approximately 3 months. It will be scheduled to be finished and operational in time for generation facility testing.

2.3.18.4 Water Pipelines

Project water pipelines will be installed underground. Power for the pumps also will run underground along the pipeline routes. The pipeline routes to the City of Avenal water turnout and to backup supply Wells 18-1 and 18-4 (Figure 2.1-5), which run near the canal, have been designed to stay outside of the grasslands that occur within the canal right-of-way. Installation will involve typical construction activities including: trenching; hauling and stringing of pipe along the routes; welding; radiographic inspection and coating of pipe welds; lowering welded pipe into the trench; hydrostatic testing; backfilling, and restoring the approximate surface grade. The Project water pipelines are expected to take a total of approximately 3 months to complete. Construction of pipelines to the existing wells will be scheduled as needed. Construction of the Project surface water supply interconnection to the City of Avenal water turnout will be coordinated with the City. Water for construction will be obtained from nearby Well 18-4 while the pipelines are being completed.

2.3.18.5 Construction Plan

The EPC contractor will be responsible for the design, procurement and construction of the facility. The EPC contractor will select subcontractors for certain specialty work as required.

2.3.18.6 Mobilization

The EPC contractor will mobilize approximately during the fourth quarter of 2002. Site preparation work will include Site grading and stormwater control as outlined in Section 2.3.17. Gravel and road base material will be used for temporary roads, laydown, parking and work areas.

2.3.18.7 Construction Offices, Parking and Laydown Areas

Mobile trailers or similar suitable facilities (e.g., modular offices) will be used as construction offices for owner, contractor and subcontractor personnel. Construction laydown and parking areas will be within the 148-acre Site as shown in Figure 2.3-12. Site access will be controlled for personnel and vehicles. A security fence will be installed around the Site boundary, including the laydown area.

2.3.18.8 Emergency Facilities

Emergency services will be coordinated with the local fire department and hospital. An urgent care facility will be contacted to set up nonemergency physician referrals. First-aid kits will be provided around the Site and regularly maintained. At least one person trained in first aid will be part of construction staff upon mobilization. Fire extinguishers will be located throughout the Site at strategic locations at all times during construction.

2.3.18.9 Construction Utilities and Site Services

During construction, temporary utilities will be provided for the construction offices, laydown area and Project Site. Temporary construction power will be utility-furnished power. Area lighting will be provided and strategically located for safety and security. Construction water will be provided by groundwater from the existing wells. Average daily use of construction water is estimated to be about 8,000 gallons.

For construction activities including hydrotesting of the HRSGs and associated piping, a maximum daily water usage is estimated at 85,000 gallons. The hydrotesting of the HRSG and other piping is normally done toward the end of project construction after the mechanical construction is complete. The hydrotest water will be sampled and tested. Water with suitable chemistry will be routed to the retention basin. If the water quality is not suitable for routing to the retention basin, the water will be transported by trucks to an appropriately licensed offsite treatment or disposal facility.

The EPC contractor will provide the following site services:

- Environmental health and safety training
- Site security
- Site first aid
- Construction testing (NDE, hydro, etc.)
- Site fire protection and fire extinguisher maintenance
- Furnishing and servicing of sanitary facilities

- Trash collection and disposal
- Disposal of hazardous materials and waste in accordance with LORS
- Erosion control during construction activities

2.3.18.10 Construction Materials and Equipment

Construction materials such as concrete, structural steel, pipe, wire and cable, fuels, reinforcing steel, and small tools and consumables will be delivered to the Site by truck.

Most large or heavy equipment will be transported to the area via Interstate 5 or by rail. Rail deliveries will be off-loaded and transported by a specialized heavy-haul contractor. Construction deliveries are further described in Section 6.11 - Traffic and Transportation.

2.3.18.11 Construction Disturbance Area

The Site is presently agricultural land that has been subjected to continuous farming use. It has no native vegetation or natural habitat, as shown in the aerial photograph in Figure 2.1-5. Estimated acreages of land that will be occupied by construction and operation of the Project are presented in Table 2.3-7.

2.3.19 FACILITY OPERATION

The Project will employ about 30 full-time permanent personnel. The Project will be controlled and operated by four individuals during each operating shift (four crews of 4 operators per crew, for a total of 16 operators). More maintenance and supervisory personnel will be present during the day shift (total of 14 management, supervisory and I.B.E.W. represented technical craft employees). As required by specific operations or maintenance activities, additional personnel may be present during evening and night shifts. The Project will not only provide high-paying, skilled employment in Avenal, but also will create significant secondary employment for providing materials and services in support of the Project. The Project will be operated up to 7 days per week, 24 hours per day. When the Project is not operating, personnel will be present as necessary for maintenance and to prepare the unit for startup. If extended outages occur when no operations or maintenance activities are in progress, at least one individual will be onsite for security purposes.

TABLE 2.3-7

ESTIMATED ACREAGE OF CONSTRUCTION AND OPERATIONS AREAS[1]

PROJECT COMPONENT	ESTIMATED AREA (acres)		NOTES
	Temporary (Construction Only)	Permanent (Operations)	
Power Generation Facility	28	22	Temporary construction includes laydown, topsoil storage, parking and construction office area. Permanent disturbance is the area within the fence line including the power block, switchyard, ZLDF, cooling tower and stormwater retention basin.
Plant Access Road	6	2	Road length is approximately 2,610 ft from the pavement on Avenal Cutoff Road to the power block entrance. Permanent disturbance is 30 sq ft wide (20-ft-wide pavement plus 5-ft shoulder on each side); temporary construction disturbance is 70 ft wide (not including permanent road area). Temporary disturbance also includes an additional 2 acres for a road to the construction laydown area.
Transmission Line Interconnection	2	<1	Transmission line from the Site switchyard to existing PG&E Gates-ARCO line is about 7,000 ft in length, requiring seven structures. Each structure will require approximately 10,000 sq ft of temporary disturbance (total of 70,000 sq ft). Permanent average disturbance of 1,200 sq ft per structure will be required (total of 8,400 sq ft).
Natural Gas Pipeline Interconnection	5	0	Approximately 4,000 ft of the pipeline interconnection will occur outside Avenal Cutoff Road and Plymouth Avenue rights-of-way, with an average disturbance corridor of approximately 50 ft. Work within the existing City rights-of-way is not included in this calculation because work will occur entirely within the paved width of the roads and the dirt shoulders that have no cover vegetation.
Water Supply Pipelines	10	0	Water supply pipeline 1.8 miles in total length from three wells to the power block battery units. No temporary or permanent access road is required. Construction disturbance will average 50 ft wide.
TOTAL	**51**	**25**	--

(1) Project facilities will occur entirely on land that has been intensively disturbed by agricultural activities. No new ground disturbance will occur due to the Project.

Overall annual availability of the Project is expected to be approximately 90 percent or greater as described in Section 2.3.15.1. The Project's capacity factor will depend on the demand for electricity and ancillary services. Project design provides for operating flexibility (i.e., ability to start up, shut down, turn down and provide peaking output) so that operations may be readily adapted to changing conditions in the energy market.

2.4 TRANSMISSION LINES DESCRIPTION, DESIGN AND OPERATION

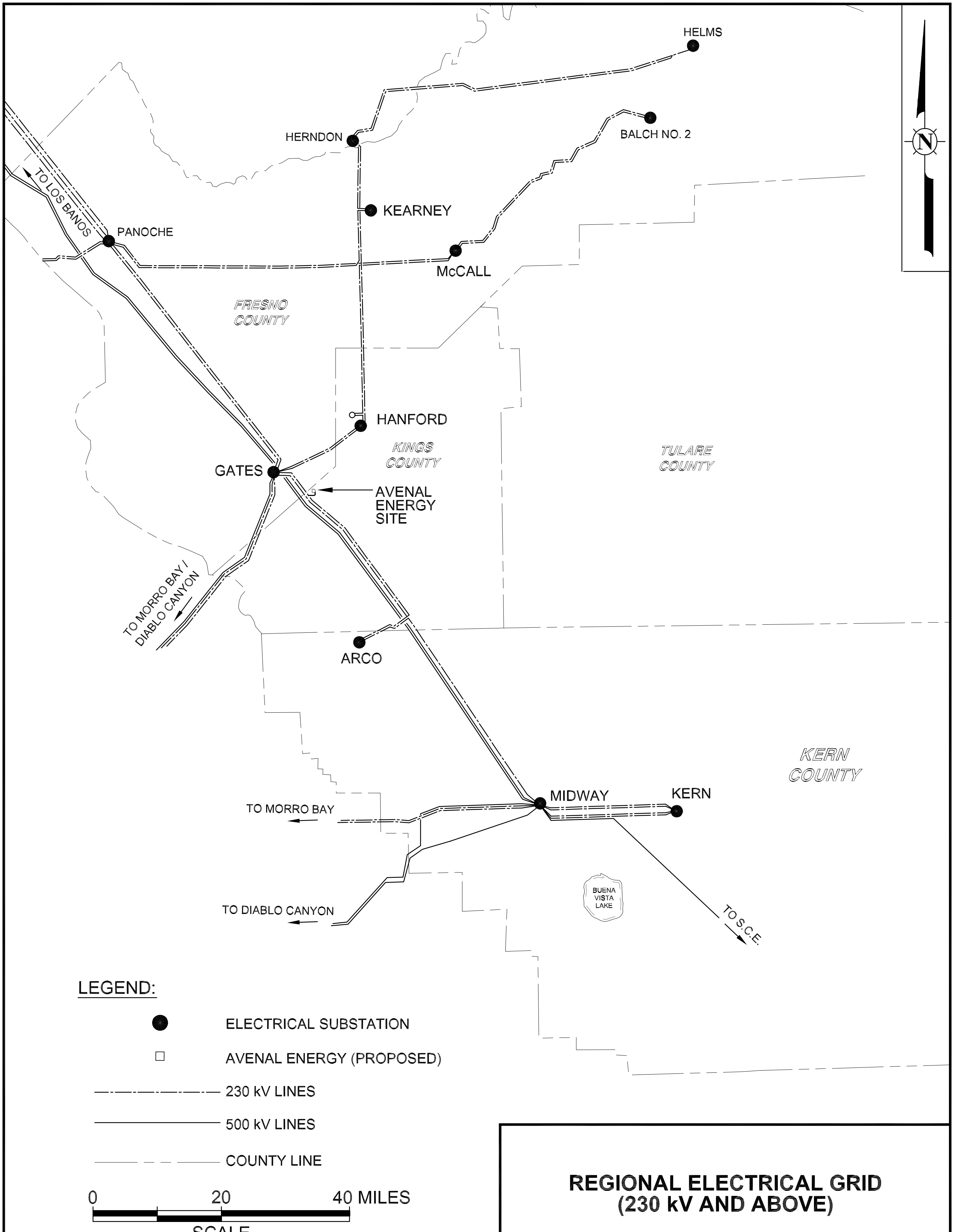
This section describes the transmission facilities that will interconnect the Project to the existing PG&E transmission system. It also describes route and facility selection considerations and discusses integration of the Project with the existing system.

The Project will provide electrical power to the grid via an interconnection to a major north-south electrical transmission right-of-way that passes within 3,000 feet to the southwest of the Site. One Gates-Midway 500-kV line, one Los Banos-Midway 500 kV line, and one Gates-ARCO 230-kV line are located in this right-of-way. The Gates-ARCO 230-kV line consists of two 795 kcmil ACSR conductors per phase, capable of carrying about 592 MW of power at a wind velocity of 2 feet per second. The PG&E Gates substation is located approximately 5 miles northwest of the Site. Figures 2.4-1 and 2.4-2 provide a regional view of the PG&E electrical transmission lines and substations in the vicinity of the Site.

2.4.1 INTERCONNECTION TO THE TRANSMISSION GRID

The Site is located in an agricultural region, and the transmission line interconnection will be located entirely over land that is actively farmed. A 1:24,000 scale map of the interconnecting route is provided in Figures 2.1-1 and 2.1-5. Area land use is described in detail in Section 6.9 - Land Use. There are no settled areas, parks, recreational areas or scenic areas within 1 mile of the interconnection route.

Duke Avenal will interconnect the Project as follows: The existing PG&E Gates-ARCO 230-kV line will be "looped into" the Site using a new double-circuit line to be constructed from the PG&E corridor to the Site. This new double-circuit 230-kV line will be routed from the east side of the existing Gates-ARCO 230-kV line to the Project switchyard. Figure 2.4-3 is a one-line diagram of the generating facility and switchyard. Figures 2.4-4 and 2.4-5 show the physical routing of the existing transmission lines in the vicinity of the Site, east of the Gates-ARCO 230-kV line. They include the short line additions required to loop this Gates-ARCO 230-kV line into the plant's switchyard. The plot plan in Figure 2.3-3 shows the location of the switchyard in relationship to the plant.



REFERENCE:

"ELECTRIC TRANSMISSION SYSTEM SHOWING POWER PLANTS AND SUBSTATIONS", BY P.G.&E., DATED JANUARY 1, 1986

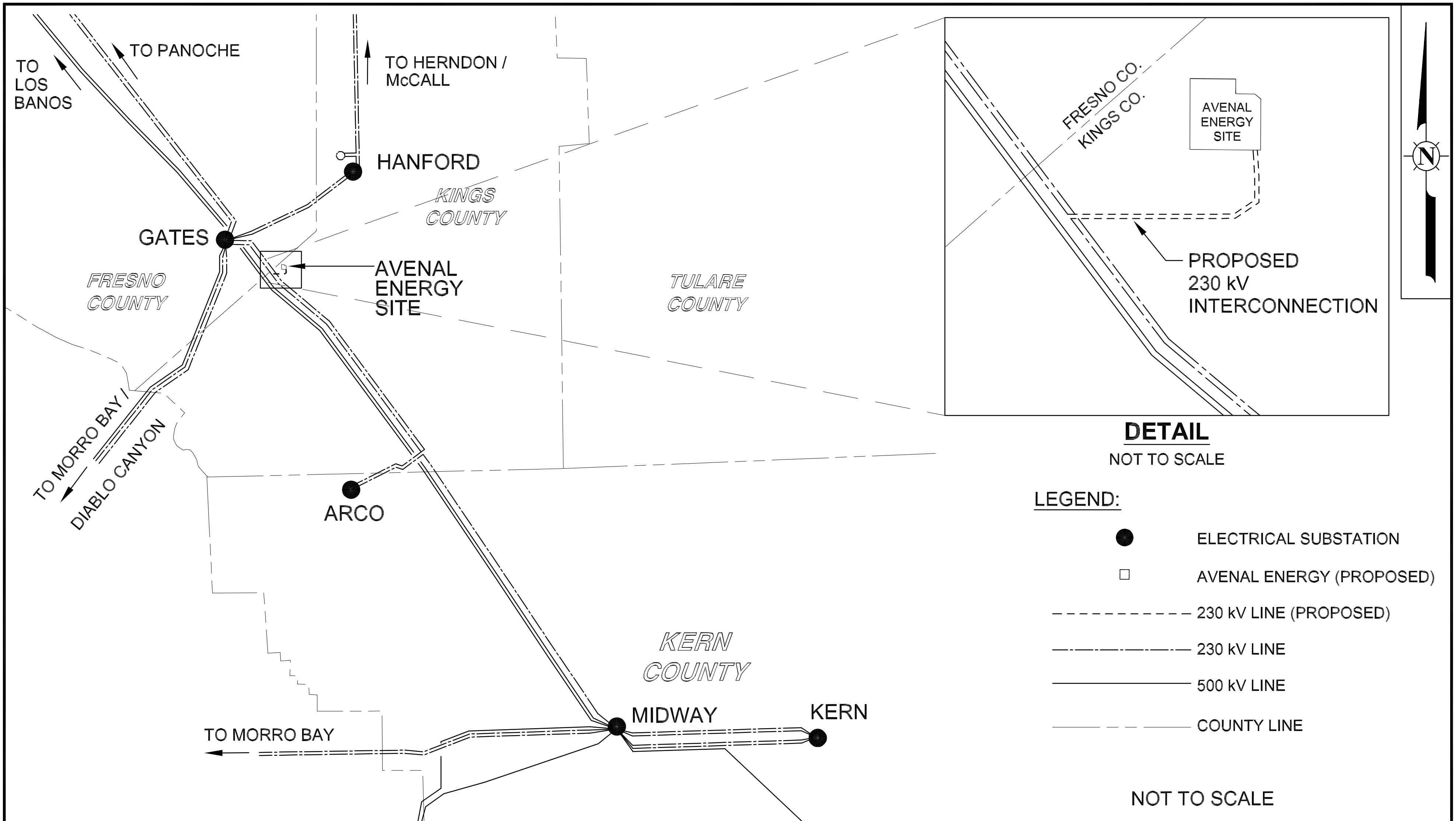
REGIONAL ELECTRICAL GRID (230 kV AND ABOVE)

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	FIGURE 2.4-1

A00-311AFC-08 REV. 8/21/01

A00-311AFC-06 REV. 9/27/01



REFERENCE:
"ELECTRIC TRANSMISSION SYSTEM SHOWING POWER PLANTS AND SUBSTATIONS", BY P.G.&E., DATED JANUARY 1, 1986

LOCAL ELECTRICAL GRID (230 kV AND ABOVE)

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY | **FIGURE 2.4-2**

The transmission line interconnection will be located on a 120-foot wide right-of-way. The land owner will provide an easement to Duke Avenal for this right-of-way, and Duke Avenal will convey the right-of-way to PG&E.

2.4.2 DELIVERY OF PROJECT ENERGY

The power produced by the Project will be delivered to the PG&E transmission system at an onsite 230-kV switchyard. From there the power will flow to the PG&E transmission system via the newly formed Avenal-Gates and Avenal-ARCO 230-kV lines. From Gates and ARCO, power generated by the Project will flow to serve local loads in the San Joaquin Valley and surrounding areas.

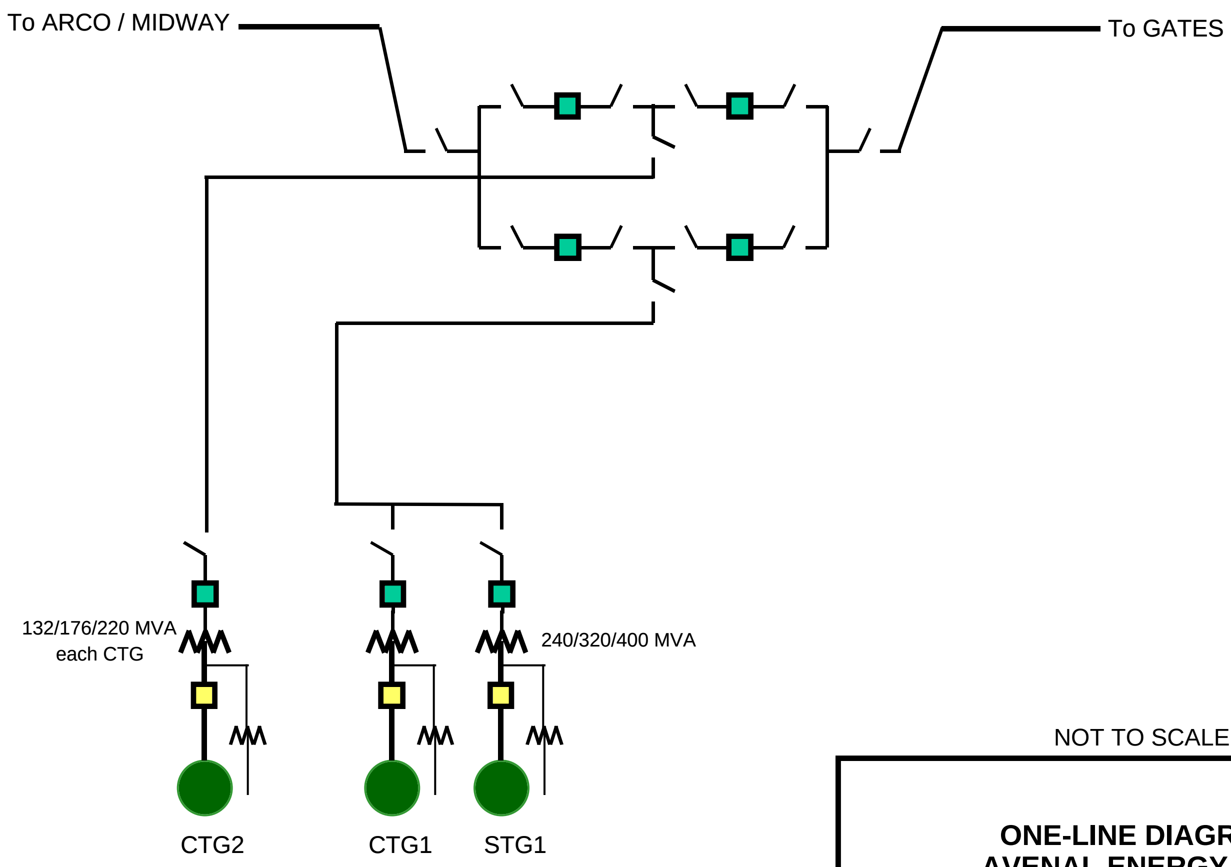
Surplus power from the Project and other plants in the Midway-Gates area will find its way south on Path 26 or north on Path 15, depending on overall system conditions and on the season of year. Once the Project is in operation, the California ISO will manage flow on these two paths in accordance with congestion management procedures in effect at that time.

2.4.3 STRUCTURES

The interconnection line will be constructed on a lattice-type tower structure capable of accommodating two bundle 954 SSAC 230-kV circuits. Figure 2.4-6 depicts a typical double-circuit steel lattice structure. This structure is characterized by multiple galvanized steel members laced together to form a steel tower approximately 120 feet high. No anchor guys are utilized for this type of the structure.

If, during the detailed design phase of the Project, it is determined that single-circuit structures are required at particular locations (such as the last structure outside the switchyard), the single-shaft tubular steel or concrete poles with post insulators may be utilized. Figure 2.4-7 shows a typical single-circuit tubular steel pole structure with davit arms that support suspension insulators to which the conductors are attached.

Color photo-simulations of a representative aboveground section of the interconnection route prior to and following construction are provided in Figures 2.4-8.

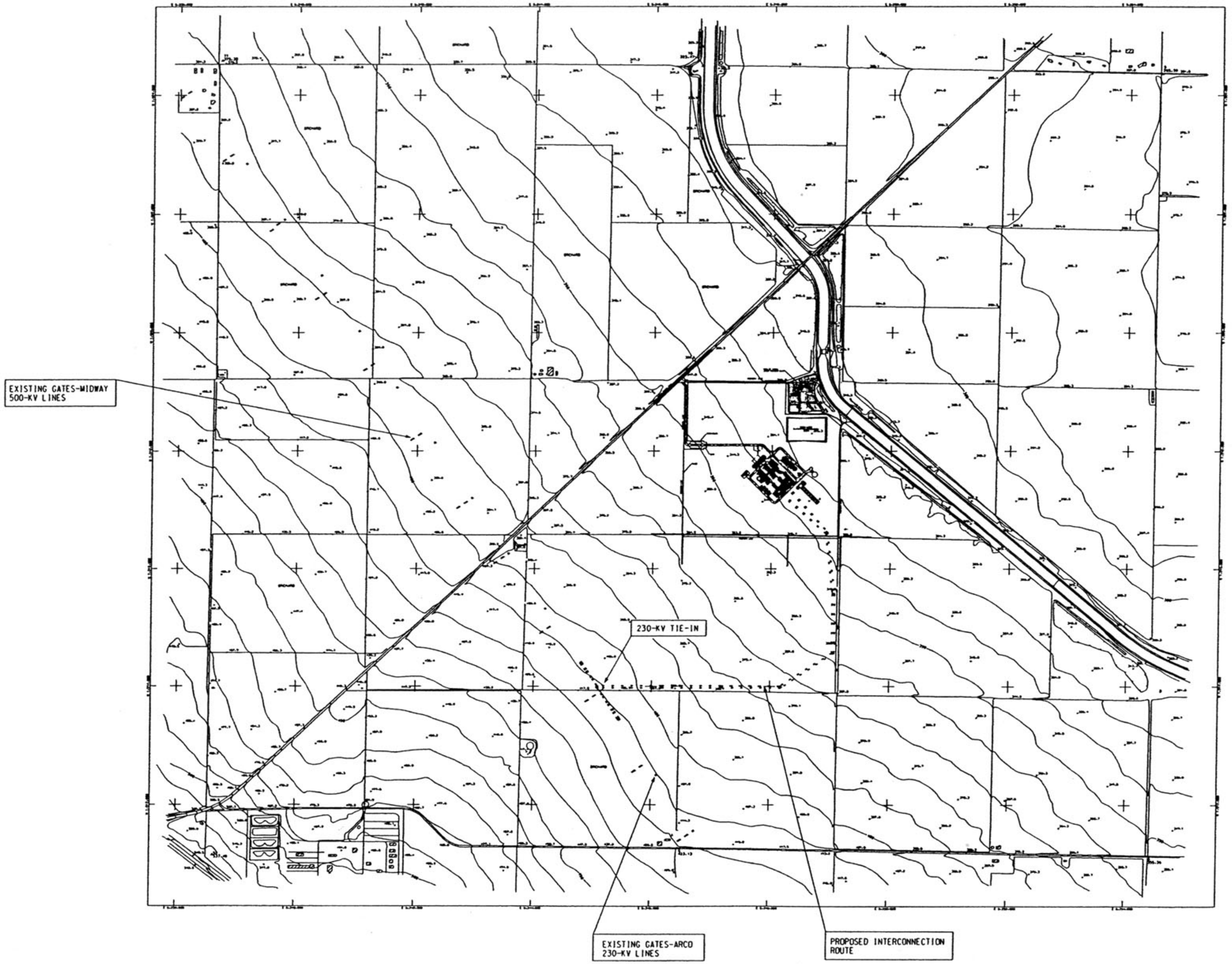


NOT TO SCALE

ONE-LINE DIAGRAM
AVENAL ENERGY SITE

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY **FIGURE 2.4-3**



0' 250' 500' 1000' 1500' 2000'
REDUCED PRINT SCALE

REV.	DATE	REVISION DESCRIPTION	DRWN / CHK.	LAYO / MECH	CIVIL / ELEC	ENGM / PROJ
A	7/19/01	ISSUED FOR REVIEW	BC			
B	8/15/01	PRELIMINARY	BC			
C	8/23/01	UPDATED TIE-IN	BC			

REV.	DATE	REVISION DESCRIPTION	DRWN / CHK.	LAYO / MECH	CIVIL / ELEC	ENGM / PROJ

DWG.NO.	REFERENCE DRAWINGS

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	INITIALS/DATE
DRAWN BY: B. CHENG	
CHECKED BY	
LAYOUT APPROVAL	
MECHANICAL APPROVAL: H. REINHART	
CIVIL APPROVAL	
ELECTRICAL APPROVAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR: T. MUALLEM	

DUKE ENERGY AVENAL, LLC
AVENAL ENERGY PROJECT
AVENAL, CALIFORNIA

FIGURE 2.4-4
TRANSMISSION LINE ROUTING
CONCEPTUAL DESIGN

SCALE	CONTRACT NUMBER	UNIT No	DOC TYPE	UNC	SUBJECT CODE	SEQ No	REV.
1"=2000'	226879	0	PP	5	AS-01		C

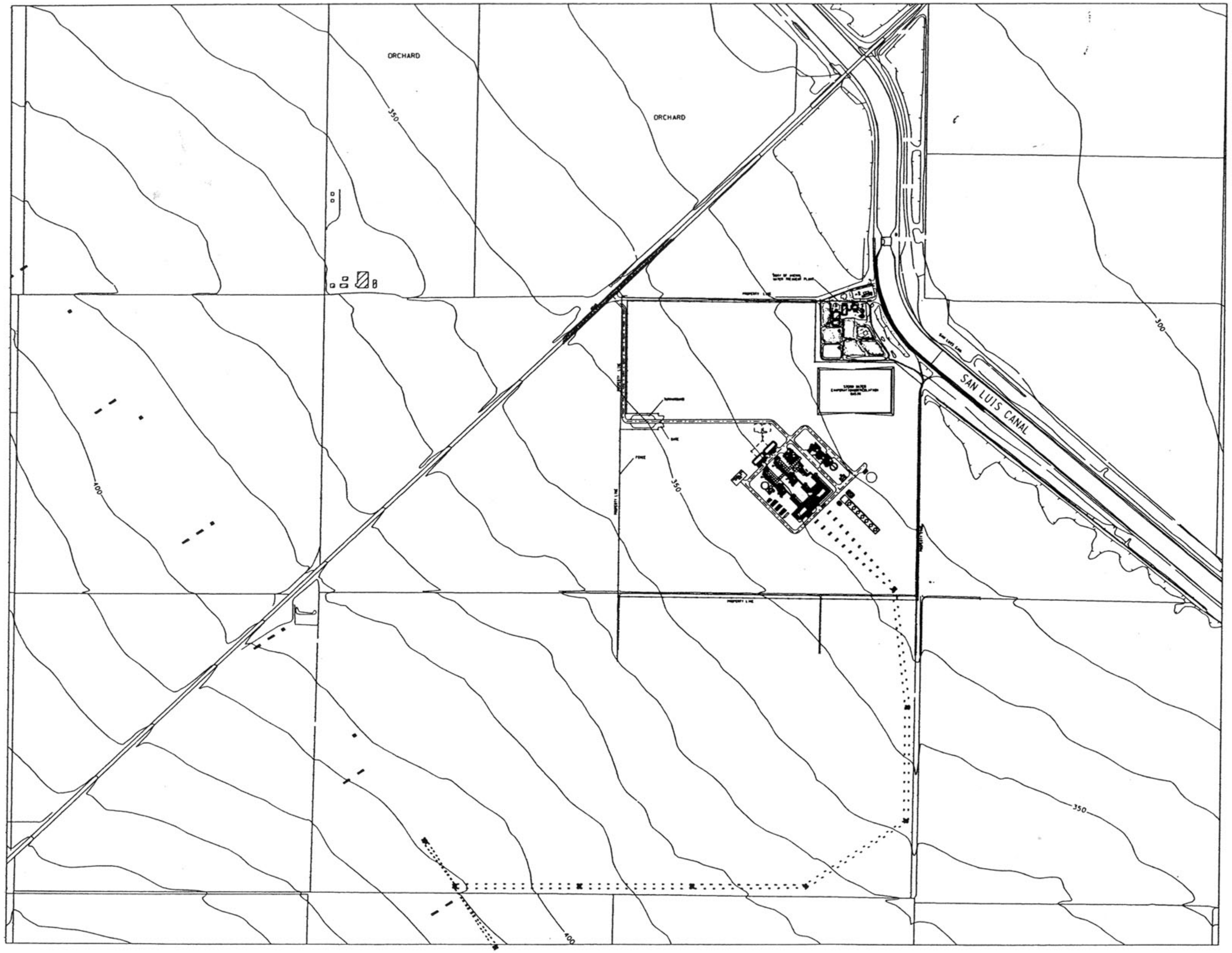
CADD FILE No. WRK. PKG. DIST. CODE CONTRACT PKG.

DFD_D.DGN 11-17-99 REV 02

Plot User $$$$USERNAME$$$$ Plot Date & Time $$$$SYTIME$$$$$$$ *DATE*TIME* MANUAL CHANGES MADE - YES ☐ NO ☐ DWG. FILE UPDATED - YES ☐ NO ☐ MODEL UPDATED - YES ☐ NO ☐

AS01.DGN

$$$DGNSPEC$$$$$$$$$$$$$$$$$$$$$$



0' 250' 500' 1000' 1500' 2000'
REDUCED PRINT SCALE

REV.	DATE	REVISION DESCRIPTION	DRWN CHK.	LAYO MECH	CIVIL ELEC	ENGM PROJ.
A	7/19/01	ISSUED FOR REVIEW	BC			
B	8/15/01	PRELIMINARY	BC			
C	8/23/01	UPDATED TIE-IN	BC			

REV.	DATE	REVISION DESCRIPTION	DRWN CHK.	LAYO MECH	CIVIL ELEC	ENGM PROJ.	DWG.NO.	REFERENCE DRAWINGS

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	INITIALS/DATE
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CHECKED BY	
LAYOUT APPROVAL	
MECHANICAL APPROVAL H. REINHART	
CIVIL APPROVAL	
ELECTRICAL APPROVAL	
ENGINEERING MANAGER	
PROJECT DIRECTOR T. MUALLEM	

DUKE ENERGY AVENAL, LLC
AVENAL ENERGY PROJECT
AVENAL, CALIFORNIA

FIGURE 2.4-5
TRANSMISSION LINE INTERCONNECTION
CONCEPTUAL DESIGN

SCALE	CONTRACT NUMBER	UNIT No	DOC TYPE	UNIQ	SUBJECT CODE	SEQ No	REV.
1"=1000'	226879	0	PP	5	AS-02	—	C

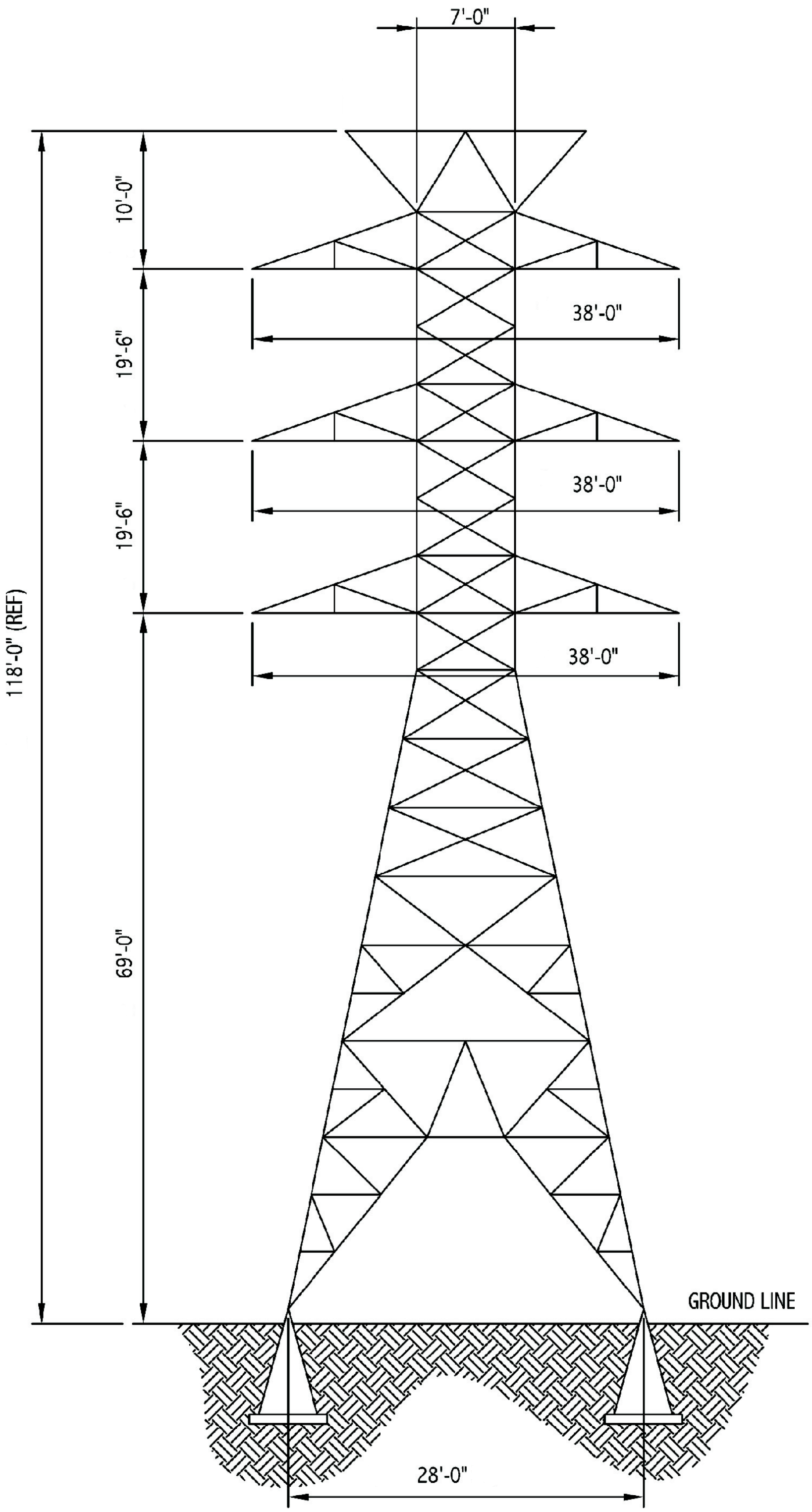
CADD FILE No. $$$DGNSPEC$$$
CONTRACT PKG.
WRK. PKG.
DIST. CODE

Plot User $$$USERNAME$$$$ Plot Date & Time $$$$SYTIME$$$$$$

•DATE•TIME• MANUAL CHANGES MADE - YES ☐ NO☐ DWG. FILE UPDATED - YES ☐ NO☐ MODEL UPDATED - YES ☐ NO☐

AS02.DGN

DFD_D.DGN 11-17-99 REV 92



NOTES:

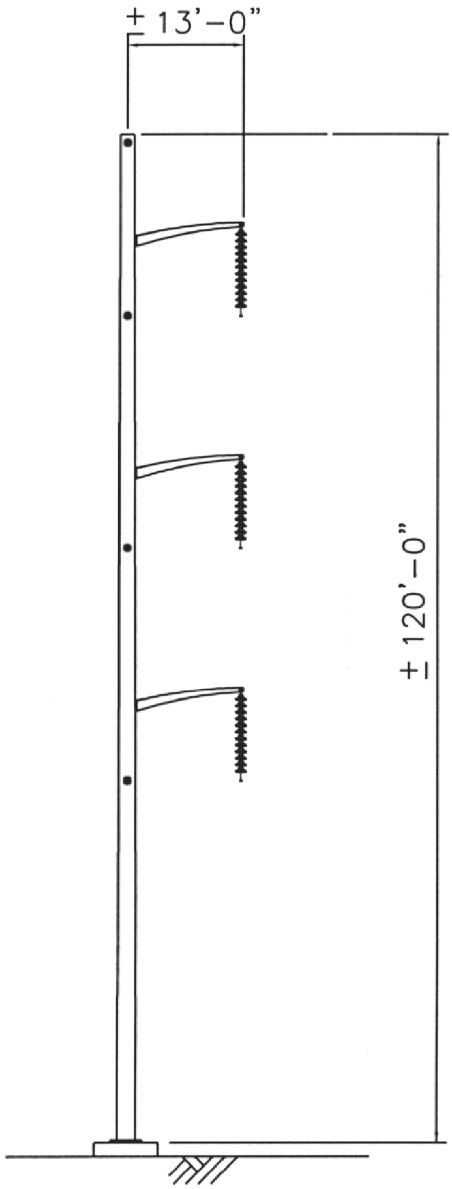
1. VIEW SHOWN IS A SUSPENSION TOWER AS VIEWED FROM THE LINE DIRECTION

NOT TO SCALE

TYPICAL DOUBLE-CIRCUIT LATTICE STRUCTURE

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	**FIGURE 2.4-6**



SINGLE CIRCUIT TUBULAR STRUCTURE
NOT TO SCALE

TYPICAL SINGLE-CIRCUIT TUBULAR STEEL POLE STRUCTURE

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY	**FIGURE 2.4-7**

Before Project Construction: The one existing 230 kV PG&E transmission line and the two existing 500 kV PG&E transmission lines are shown in the mid-ground of the photograph.

After Project Construction: The Project transmission line interconnection is shown at the left side of the photograph.

REPRESENTATIVE SECTION VIEW OF TRANSMISSION LINE CORRIDOR

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY | **FIGURE 2.4-8**

2.4.4 CONDUCTORS

The selection of conductors for looping the Gates-ARCO 230-kV line into the Project switchyard will be based on possible future use of the new Avenal-Gates and Avenal-ARCO lines. The conductor will be sized to carry the full output of the power plant. This conductor will also be used for the overhead strain bus along with the tubular bus (5" or 6") within the switchyard ring bus. The current plan is to construct the interconnection between the Site and PG&E's transmission corridor using bundle 954 SSAC conductor.

2.4.5 IMPACT ON EXISTING TRANSMISSION SYSTEM

Pursuant to PG&E Transmission Owners (TO) Tariff, Duke Avenal signed a System Impact Study (SIS) Agreement so that PG&E will proceed to perform an SIS study for the Project. After the SIS study is completed, PG&E will perform a Facility Study to identify alternative solutions to any problem identified in the SIS. Duke Avenal will discuss the proposed solutions with PG&E and the California ISO. Once an agreement is reached with PG&E and the California ISO on alternative solutions, Duke Avenal will forward the corresponding report to the Commission for its review. The final SIS report, expected to be available by the end of 2001, will provide information regarding any necessary transmission upgrades to interconnect the Project into the PG&E transmission system. Results of Duke Avenal's preliminary interconnection studies (Appendix 6.18-2) indicate that impacts to the PG&E system are expected to be minimal and limited to reconductoring a very short section of line within the Gates substation.

2.4.6 TRANSMISSION LINE INTERCONNECTION ROUTE AND FACILITIES SELECTION

The transmission line route and facilities have been selected to maximize efficiency and minimize environmental impacts. Because topography in the Site vicinity is relatively featureless, transmission lines could be routed in any direction without topographic constraints. Several routes were analyzed for potential use as further described in Chapter 5.0 - Alternatives Analysis, and the selected route was found to have the lowest environmental impact, primarily due to the following:

- The route is located far from residences and other potentially conflicting land uses.
- The route is designed to leave the Site from the back of the power block and maintain distance from Avenal Cutoff Road and other area roadways, so visual impacts will be minimal.

- The route has been designed in consultation with the farmer operating in the field on which the route occurs, to minimize impacts on agricultural operation. The route is located entirely within active agricultural land, so impacts to the natural resources are minimized.

As described in Chapter 5.0, other transmission line interconnection routes would have increased environmental impacts compared to the selected route.

Due to relatively featureless terrain, various routes were evaluated for the loop-in interconnection to the Gates-ARCO line. These routes were evaluated to determine if impacts could be reduced compared to the selected route. As described above, the selected route was found to be most favorable from the perspective of minimizing environmental impacts. Each of the routes evaluated for the loop-in would have a similar effect on the host transmission system.

An alternative method was considered by which the Project would be connected via a radial 230-kV, double-circuit line to the Gates substation, using an available open 230-kV position at Gates. There was no technical justification found for the added expense and the possible environmental affects that would occur to construct the longer interconnection tie-in to the Gates substation to implement this alternative.

2.5 APPLICABLE LAWS, ORDINANCES, REGULATIONS AND STANDARDS

The LORS that are or may be applicable to the design and construction of the Project are listed in Tables 2.5-1, 2.5-2, 2.5-3 and 2.5-4. The LORS are presented by topic and organized into federal, state, local and industry codes/standards. Applicable LORS that are relevant to individual environmental resource topics are addressed in Chapter 6.0 - Environmental Information. Table 2.5-5 provides a listing of administrative agencies with jurisdiction to enforce identified LORS.

2.5.1 ENGINEERING GEOLOGY

Unless specifically stated otherwise, the design of structures and facilities will be based on the laws, ordinances, codes, specifications, industry standards and regulations, and other reference documents in effect at the time of design. Applicable codes and industry standards with respect to engineering geology are summarized in sections of Appendix 2-1, "Foundations and Civil Engineering Design Criteria," and Appendix 2-2, "Structural and Seismic Engineering Design Criteria."

TABLE 2.5-1

SUMMARY OF ENGINEERING LORS AND COMPLIANCE

JURIS-DICTION	LORS/AUTHORITY	ADMINISTERING AGENCY[1]	REQUIREMENTS/COMPLIANCE	APPROACH TO COMPLIANCE	AFC SECTION
Project Siting and Construction					
Federal	29 USC § 651 et seq., 29 CFR §§1901.1-1910, 1500; 29 CFR, Part 1926.	OSHA; Cal-OSHA per 29 CFR §§1952.70-1952.175	Specific occupational safety and health standards. Project will meet applicable standards and will comply with OSHA worker safety regulations.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendix 2-1: Foundations and Civil Engineering Design; Appendix 2-2: Structural and Seismic Engineering Design Criteria; Section 2.3.17 Project Civil/Structural Features, 6.17 Worker Safety
State	Business and Professions Code §6700 et seq., §§ 6730, 6736 and 6736	Board for Professional Engineers and Land Surveyors	Requires state registration practice as a civil or structural engineer in California and that all plans, specifications, reports, or documents must be prepared by or under the direction of a registered engineer. Engineering design will use registered engineers as required.	Appropriate engineering, design and construction drawings and engineering calculation will be signed by registered engineers.	Appendix 2-1: Foundations and Civil Engineering Design; Appendix 2-2: Structural and Seismic Engineering Design Criteria; Section 2.3.17 Project Civil/Structural Features
State	Labor Code §6500 et seq.	Cal-OSHA	Requires a permit for construction of trenches or excavation 5 feet or deeper into which personnel have to descend. Project will obtain required permits.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Section 2.2.15 Project Civil/Structural Features Appendices 2-1 and 2-2
State	CBC (latest edition available)	Commission	Sets building standards and requirements. Project will comply with the latest CBC applicable requirements.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Section 2.2.13.2 Seismic Safety Appendices 2-1 and 2-2, 6.3 Geologic Hazards and Resources
State	Labor Code §6300 et seq., 8 CCR 1500 et seq., 2300 et seq., §3200 et seq.	Cal-OSHA	Prescribes construction safety orders, industrial safety orders and work safety requirements. Project will comply with applicable safety requirements.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-1 and 2-2, 6.17 Worker Safety

[1] Pursuant to CCR Title 20, Appendix B(h)(1)(B): Each agency with jurisdiction to issue applicable permits and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the Commission to certify sites and related facilities.

TABLE 2.5-1

SUMMARY OF ENGINEERING LORS AND COMPLIANCE (Continued)

JURIS-DICTION	LORS/AUTHORITY	ADMINISTERING AGENCY[1]	REQUIREMENTS/COMPLIANCE	APPROACH TO COMPLIANCE	AFC SECTION
State	Vehicle Code §35780 et seq.	Caltrans	Requires permit for transportation of oversize or overweight vehicles over state highways. Project will obtain the applicable permits.	Oversize and heavy load permits will be obtained from Caltrans with copies provided to the Commission.	Appendices 2-1 and 2-2, 6.11 Traffic and Transportation
Industry	See "Civil Engineering Design Criteria" (Appendix 2-1) and "Structural Engineering Design Criteria" (Appendix 2-2).	Not applicable	Project will meet design criteria.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	2.3.17.2, 2.3.17.3, 2.3.17.4, 2.3.17.5 Pages 2-59 through 2-62
Industry	Various Industry/ Association Codes	Various. See Table 7-5.	Industry codes and trade association standards, usually for equipment.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Section 2.3.3 - Facility Layout; Section 2.3.4 - Facility Design Page 2-19
Local	Kings County Code of Building Regulations	Commission	Sets building standards and requirements for Kings County.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-1 and 2-2
Local	Kings County Code of Building Regulations	Commission	Specifies drainage and grading requirements. Project will comply with applicable drainage and grading requirements.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-1 and 2-2
State	CBC; California Plumbing Code	Commission	Sets building standards and requirements. Project will comply with applicable CBC requirements.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-3 and 2-4, 6.3 Geologic Hazards and Resources

[1] Pursuant to CCR Title 20, Appendix B(h)(1)(B): Each agency with jurisdiction to issue applicable permits and approvals or to enforce identified laws, regulations, standards, and adopted local, regional, state and federal land use plans, and agencies which would have permit approval or enforcement authority, but for the exclusive authority of the Commission to certify sites and related facilities.

TABLE 2.5-1

SUMMARY OF ENGINEERING LORS AND COMPLIANCE (Continued)

JURIS-DICTION	LORS/AUTHORITY	ADMINISTERING AGENCY[1]	REQUIREMENTS/COMPLIANCE	APPROACH TO COMPLIANCE	AFC SECTION
State	8 CCR Chapters 4-7	Commission	Prescribes requirements for flammable liquids, gases, and vapors. Project will comply with applicable requirements.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-3 and 2-4
State	Business and Professions Code §6700 et seq., 6730, 6735 & 6736	Board of Professional Engineers and Land Surveyors	Requires state registration to practice as a mechanical engineer and that plans, specifications, reports, or documents be prepared by a registered engineer. Engineering design will use registered engineers as required.	Appropriate engineering, design and construction drawings and engineering calculation will be signed by registered engineers.	Appendices 2-3 and 2-4
State	CBC; California electrical code	Commission	Sets building standards and requirements. Project will comply with applicable CBC requirements.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-4 and 2-5
Project Design and Operation					
Federal/State	National Fire Protection Association standards	Fed-OSHA and Cal-OSHA	Project will meet standards necessary to establish a reasonable level of safety and property protection from the hazards created by fire and explosion.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Section 2.3.11 Facility Safety and Emergency Systems
Federal/State	See Appendices 2-1 to 2-5	Fed-OSHA and Cal-OSHA	Project will comply with industry standards regarding worker safety and health protection.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Appendices 2-1 to 2-5, and 6.17 - Worker Safety

TABLE 2.5-1

SUMMARY OF ENGINEERING LORS AND COMPLIANCE (Continued)

JURIS-DICTION	LORS/AUTHORITY	ADMINISTERING AGENCY(1)	REQUIREMENTS/COMPLIANCE	APPROACH TO COMPLIANCE	AFC SECTION
State	Executive Order D-23-01	CAISO	Submit planned outage schedules to the Independent System Operator.	Applicable plans and schedules will be prepared and submitted to CAISO.	Section 2.3.1.5 Page 2-63
Industry	EPRI, NERC	N/A	EPRI and NERC trade association standards will be followed.	Applicable plans and drawings will be prepared and provided to the Commission for review and approval as the CBD.	Section 2.3.15 Pages 2-50 through 2-58; and Appendix 2-5: Control Systems Engineering Design Criteria
Industry	CAISO Maintenance Performance Standards & Criteria (Draft)	CAISO	Explanation in summary format during certification how each standard is being met.	The appropriate summaries and assurances will be prepared and submitted at the pertinent times.	Section 2.3.15 Page 2-63
Industry	CAISO Maintenance Guidelines for Electrical Generating Facilities (Draft)	CAISO	The standards will be used to support the Generation Maintenance Performance Standards and Criteria when revising or implementing new maintenance programs.	When developing or changing maintenance programs, these standards will be consulted and followed where applicable.	Section 2.3.15 Page 2-63
Industry	CAISO Generating Unit Performance Metrics (Draft)	CAISO	Submit the raw data required by CAISO in order to calculate the Capacity Unavailability Factor (CUF) measuring the percent of total capacity not available over a specific reporting period.	The data required by CAISO to complete the necessary CUF calculations will be prepared and submitted at the requested intervals.	Section 2.3.15 Page 2-63

TABLE 2.5-2

POTENTIALLY APPLICABLE INDUSTRY CODES AND STANDARDS

INDUSTRY/ASSOCIATION OR CODE	ACRONYM
American Association of State Highway Officials	AASHO
American Institute of Steel Construction Specifications	AISC
American National Standards Institute	ANSI
American Petroleum Institute	API
American Society for Testing and Materials	ASTM
American Society of Heating, Refrigeration, and Air Conditioning Engineers	ASHRAE
American Society of Nondestructive Testing	ASNT
American Standards for Mechanical Engineering	ASME
American Water Works Association	AWWA
American Welding Society	AWS
Asphalt Institute, Pacific Coast Division	--
California Building Code	CBC
California State Fire Marshall	CSFM
Heat Exchanger Institute	--
Hydraulic Institute Standards	--
Institute of Electrical and Electronic Engineers	IEEE
Instrument Society of America	ISA
International Brotherhood of Electrical Workers	IBEW
National Institute of Occupational Safety and Health	NIOSH
Standards of Tubular Exchanger Manufacturers Association	TEMA
Steel Structures Painting Council Standards	SSPC
Underwriters Laboratories	UL
Uniform Building Code	UBC
Uniform Fire Code	UFC
Uniform Mechanical Code	UMC
Uniform Plumbing Code	UPC

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TABLE 2.5-3

NATIONAL FIRE PROTECTION ASSOCIATION STANDARDS RELATED TO FIRE AND EXPLOSION HAZARDS

STANDARD	DESCRIPTION
NFPA 1	Fire Prevention Code
NFPA 10	Portable Fire Extinguishers
NFPA 12	Carbon Dioxide Extinguishing Systems
NFPA 13	Installation of Sprinkler Systems
NFPA 14	Installation of Standpipe and Hose Systems
NFPA 15	Water Spray Fixed Systems
NFPA 20	Centrifugal Fire Pumps
NFPA 22	Water Tanks for Private Fire Protection
NFPA 24	Private Fire Service Mains and Their Appurtenances
NFPA 30	Flammable and Combustible Liquids Code
NFPA 37	Combustion Engines and Gas Turbines
NFPA 50A	Gaseous Hydrogen Systems at Consumer Sites
NFPA 68	Explosion Venting
NFPA 69	Explosion Preventing
NFPA 70	National Electric Code
NFPA 72	National Fire Alarm Code
NFPA 78	Lighting Protection Systems
NFPA 291	Testing and Marking Hydrants
NFPA 496	Purged and Pressurized Enclosures for Electrical Equipment
NFPA 497	Flammable and Combustible Liquids Classification
NFPA 1961	Fire Hose
NFPA 1962	Care, Use and Service Testing of Fire Hose Including Couplings and Nozzles
NFPA 1963	Screws, Threads, and Gaskets for Fire Hose Connections
NFPA 2001	Clean Agent Fire Extinguishing Systems
NFPA 8501	Standard for Single Boiler Operation

31161/Rpts/AFC(Text)/Tbls&Figs (9/27/01/rw)

TABLE 2.5-4

POTENTIALLY APPLICABLE OCCUPATIONAL SAFETY AND HEALTH TOPICS PRESCRIBED BY TITLE 8 CCR

STANDARD	DESCRIPTION
Occupational Safety and Health Standards 401-428	Definitions Administration Variances Appeals Officers Hearing Board
General Industry Safety Orders; Title 8, Sections 3200-6184	Employee/Employer Communications Injury and Illness Prevention Program Emergency Action Plan Fire Prevention Plan Hazardous Materials • Control of Hazardous Substances • Hazard Communication Hazard Communication Emergency medical Procedures Personal Protective Equipment Airborne Contaminants Signs, Tags, Barriers Noise Levels Ventilation Flammable/Combustible Materials Handling and Storage Fire Protection Systems Machine Guarding Crane and Hoist Operation Heavy Equipment and Machine Operation Rigging Sanitary Facilities Traffic Safety Interface with other Contractors Miscellaneous Hazards, including hot pipes, compressed air system, relief valves, pipelines, loading docks
General Construction Safety Orders; Title 8, Sections 1500-1938	High Voltage Electrical Safety Orders Construction Accident Prevention Plan Weekly Toolbox Meetings Traffic Accidents and Earth Moving Hoist Equipment Reinforcing Concrete Fall Protection and Scaffolding Electrical Installations Evacuation Plan and Procedures Fire Safety Airborne Contaminants Emergency medical Procedures Personal Protective Equipment Hand and Power Tool Use Crane and Hoist Operation Pile Driving Illumination Housekeeping Excavations
Electrical Safety Orders Title 8, Sections 2299-2974	High Voltage Installation, Operation and Maintenance Low Voltage Hazards High Voltage Hazards

31161/Rpts/AFC(Text)/Tbls&Figs (9/27/01/rw)

TABLE 2.5-5

ENGINEERING
ADMINISTRATIVE AGENCY CONTACTS
AND PERMITTING/APPROVAL AUTHORITIES

LOCAL AUTHORITY OVERSIGHT/ENFORCEMENT AND AGENCY CONTACTS	PERMITTING/APPROVAL AUTHORITY
California Energy Commission Steve Munro 1516 9th Street, M-S 20 Sacramento, California 95814-5512 (916) 654-9936	Compliance with Engineering requirements.
California Independent System Operator Irina Green 151 Blue Ravine Road Folsom, California 95630 (916) 608-1296	Compliance with interconnection and maintenance requirements.`
City of Avenal Jim Doughty 919 skyline Boulevard Avenal, California 93204 (559) 386-5766	Compliance with Engineering requirements.

2.5.2 CIVIL AND STRUCTURAL ENGINEERING

Unless specifically stated otherwise, the design of all structures and facilities will be based on the laws, ordinances, codes, specifications, industry standards and regulations, and other reference documents in effect at the time of design. Applicable codes and industry standards with respect to civil and structural engineering design, construction and operation are summarized in Appendix 2-1, "Foundations and Civil Engineering Design Criteria," and Appendix 2-2, "Structural and Seismic Engineering Design Criteria."

2.5.3 MECHANICAL ENGINEERING

Unless specifically stated otherwise, the design of all structures and facilities will be based on the laws, ordinances, codes, specifications, industry standards and regulations, and other reference documents in effect at the time of design. Applicable codes and industry standards with respect to mechanical engineering design criteria, construction and operation are summarized in Appendix 2-3, "Mechanical Engineering Design Criteria." Applicable sections of Appendix 2-5, "Control Systems Engineering Design Criteria," will also be considered.

2.5.4 ELECTRICAL AND CONTROL SYSTEMS ENGINEERING

Unless specifically stated otherwise, the design of all structures and facilities will be based on the laws, ordinances, codes, specifications, industry standards and regulations, and other reference documents in effect at the time of design. Applicable codes and industry standards with respect to electrical and control systems engineering design, construction and operation are summarized in Appendix 2-4, "Electrical Engineering Design Criteria." Applicable sections of Appendix 2-5, "Control Systems Engineering Design Criteria," will also be considered.

2.5.5 PERMITS

A schedule for when Project permits are expected to be obtained is shown in Figure 2.5-1.

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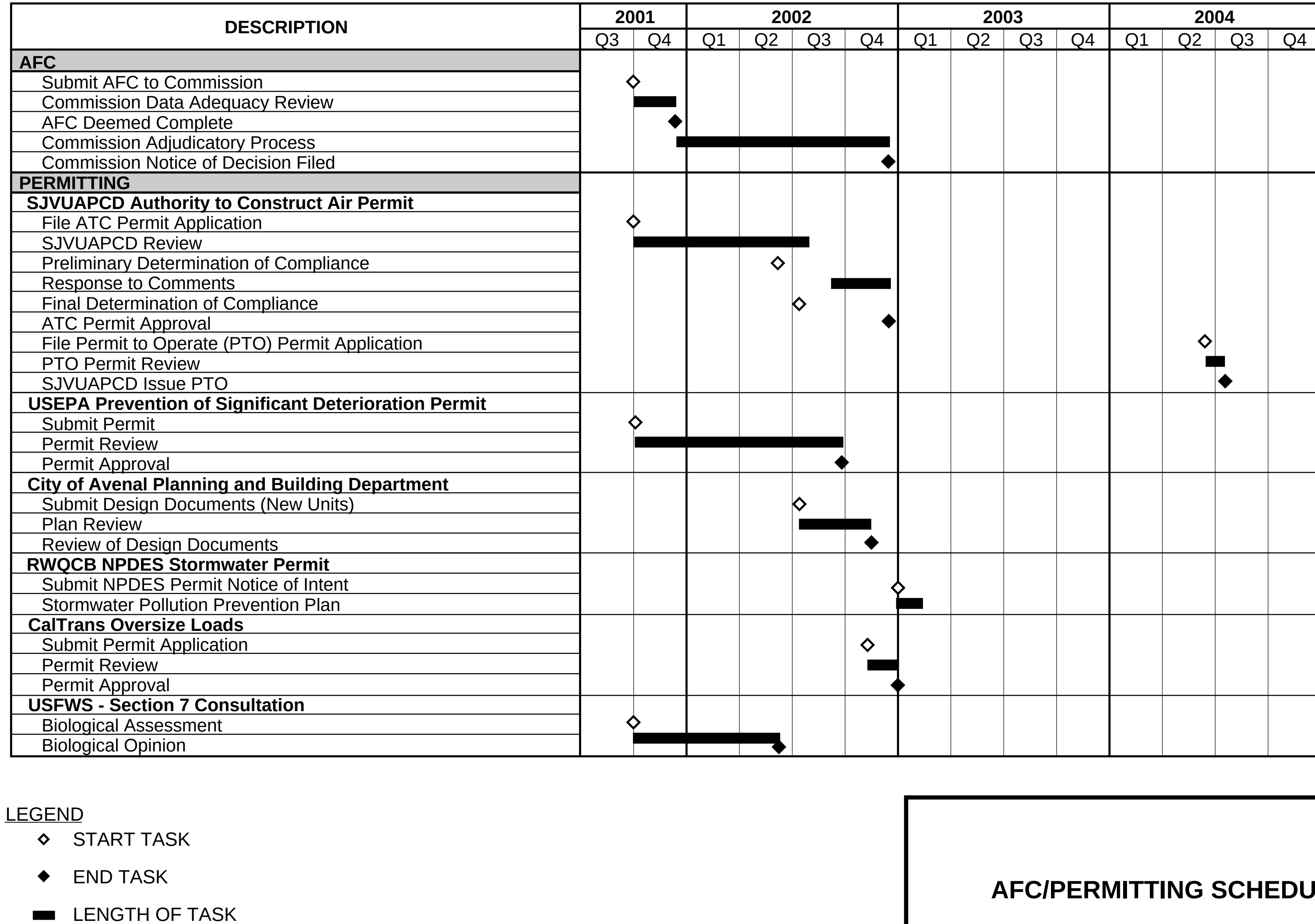

AFC/PERMITTING SCHEDULE

DUKE ENERGY AVENAL, LLC

AVENAL ENERGY

FIGURE 2.5-1